SCIENCE EDUCATION

FLORENCE GRACE BILLIG

VOLUME 42 OCTOBER, 1958 NUMBER 4

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Association for the Education of Teachers in Science

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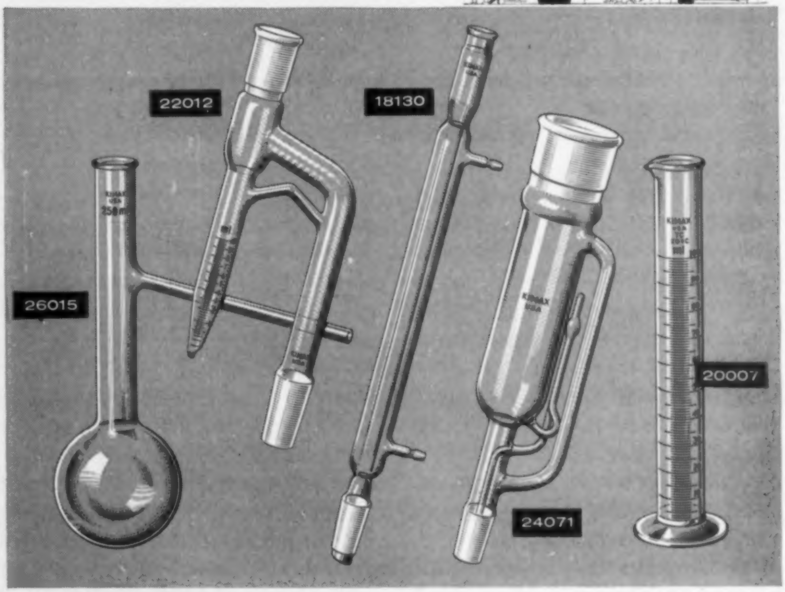

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FLORENCE GRACE BILLIG

It is indeed most appropriate that the first woman given a Science Education Recognition Award should be Doctor Florence Grace Billig. Through the years she has been a noted leader in science education, professionally active at meetings and through publications. She has the distinction of having served as the first woman president of the National Association for Research in Science Teaching, 1942–45. In a real sense she was the war-time president of N.A.R.S.T. She also served as President of the National Council for Elementary Science, 1933–34.

Florence Grace Billig was born on a farm near Harper, Ogle County, Illinois, January 2, 1890. She was the daughter of Ulysses H. and Zadie Gibbs Billig. Both maternal and paternal forbears were pioneer settlers in Ogle County. They lived in log cabins and hauled their surplus grain to old Fort Dearborn, which at that time was the nearest market.

Miss Billig graduated from Rockford High School, Rockford, Illinois, in 1906. She graduated from Northern Illinois University, DeKalb, Illinois, in 1910. She received her B.S. degree from the University of Chicago in 1915. She was a student at the Marine Biological Laboratory, Woods Hole, Massachusetts, during the summer of 1919. She did graduate work at Stanford University, Palo Alto, California, during 1922–23, and the summer of 1924. She was a student at Hopkins Marine Station, Pacific Grove, California, during the summer of 1923. She received M.S. (1919) and Ph.D. (1930) from Columbia University, New York City.

Dr. Billig's teaching career began as a rural teacher in Winnebago County, Illinois, 1906–08. She taught in the elementary schools in Palo, Illinois (1910–11) and Sioux City, Iowa (1911–13). She was instructor in science in the College Department and Supervisor of Science in the Training Department, Kansas State Teachers College, Emporia, Kansas, 1915–18 and 1919–22. She was a Supervisor of Science in the elementary and secondary schools of Sacramento, California, 1923–27 and 1929–31. She was a special instructor at the University of California, Berkeley, California, 1930–31. Summer school teaching included: State Teachers College, Arcata, California, 1925; Teachers College, Columbia University, 1929; Kent State College, Kent, Ohio, 1931; University of Nebraska, Lincoln, Nebraska, 1938. She went to Wayne State University, Detroit, Michigan in 1931. Here she remained until her retirement in 1957. Here she became Professor of Science Education and Chairman of the Science Education Department. She also served as Supervisor of Science in the Detroit elementary schools, 1931–44. Dr. Billig's many honors include: Sigma Xi (Stanford University and Wayne State University Chapter); Kappa Delta Pi, Delta Kappa Gamma; President of N.A.R.S.T., 1942–45; Vice-President, N.A.R.S.T., 1941–42; member Executive Committee, N.A.R.S.T., 1940–41; 1945–46; Fellow, American Association for the Advancement of Science; President of the National Council for Elementary Science, 1933–34; Associate Editor of *Science Education;* Chairman of Elementary Science

Section of Central Association of Science and Mathematics Teachers, 1935; member of Thirty-First Yearbook Committee, Part I of the National Society for the Study of Education; Queen of Ahmose Temple, No. 63, Daughters of the Nile, Detroit, Michigan, 1943 (an organization devoted to working for crippled children in the Shriners Hospitals for Crippled Children). Some three hundred friends, colleagues, and former students attended a reception sponsored by the Natural Science Club Alumni honoring Dr. Billig on June 11, 1957. A citation read:

To Florence Grace Billig

On the occasion of the completion of twenty-six years of devoted service to the children of Detroit, to Wayne State University, and the Board of Education.

Greetings:

For, coming from pioneer stock who crossed the country in covered wagons, being herself a pioneer daring to break new and needed ground in her chosen field of science education;

For, as an author, critical and creative, a scientist, devoted and inspiring, and as a teacher, dedicated and exacting sharing with her students a sense of the power and the beauty of knowledge;

For, in being forgetful of self, making the unforgettable impact upon colleagues, friends, and students alike who hold her in affection.

This document is presented in token of appreciation in Detroit, Michigan, June 11, 1957.

Katherine M. Banning

The members and alumni of the Natural Science Club

Robert M. Magee

For her colleagues, Wayne State University

Helen P. Reed

For her colleagues, Board of Education

Dr. Billig is listed in: American Men of Science, Who's Who in American Education, Biographical Director of Leaders in Education, Women's Who's Who, American Women, Women of Distinction in America, Who's Who in Michigan, and International Blue Book.

Membership in organizations include: N.E.A. (Life); National Society for the Study of Education (Life); N.A.R.S.T. (Life); N.C.E.S.; Kappa Delta Pi; C.A.S.M.T.; American Nature Study Society; Delta Kappa Gamma, Michigan Academy of Science; Detroit Audubon Society; Metropolitan Detroit Science Club; Sigma Xi.

Committee memberships in addition to those listed above include: National Committee on Science Teaching sponsored by the American Council of Science Teachers of the National Education Association; Chairman of Committee on Elementary Science Curriculum of the National Association for Research in Science Teaching; Science Committee, Dictionary of Education; numerous other committees such as N.C.E.S., N.A.R.S.T., American Nature Study Society, Metropolitan Detroit Science Club.

Publications include: *A Technique for Developing Content for a Professional Course in Science for Teachers in Elementary Schools* (Ph.D. Dissertation, 1930), Bureau of Publications, Teachers College, Columbia University; *Technique of Analysis to Determine Content for Science in Elementary Schools*—Chapter 11, Thirty-First Yearbook of National Society for the Study of Education; Part I, *A Program for Science Teaching,* University of Chicago Press, Chicago, Illinois, 1932; *Elementary Science in the Urban School*—Chapter IX, Forty-Sixth Yearbook, Part I—National Society for the Study of Education, Uni-

versity of Chicago Press, Chicago, Illinois, 1946; Three studies in Twentieth Yearbook of the National Society for the Study of Education, 1921; *Science Education in the Elementary Schools,* Chapter 18, Part II, *Elementary Education Program,* 1945, Department of Education, Field Service, University of Chicago, Survey, Battle Creek Schools, Battle Creek, Michigan; *Project-Problem Instruction in Elementary Science* in Lull and Wilson—Redirections of High School Instruction, p. 113–131; *What Does Research Say?* Chapter XII, *Science,* Michigan State Department of Public Instruction; Arbor Day Bulletins for 1925 and 1927 (in cooperation with the State Department of Education, Sacramento, California); suggestive outlines of science for elementary schools (developed with cooperation of staff members and committees of teachers) Kansas State Teachers College, Elementary Schools of Sacramento, California, and Elementary Schools, Detroit, Michigan; over one hundred abstracts and book reviews for *Science Education* and *Elementary School Journal;* some eighty articles in such magazines as: *Science Education, Teachers College Record, Education, Teachers Journal and Abstracts, Western Journal of Education, Normal Instructor, Nature Study Review.*

Pioneering work of Dr. Billig in the field of science education includes:

Organized the College Department of Science Teaching and developed the science work in the Training Department of the Kansas State Teachers College, Emporia, Kansas.

Developed the Science Program in Elementary Schools of Sacramento, California.

Developed the Science Program in Elementary Schools of Detroit, Michigan.

Organized the Science Education Department in Wayne State University, Detroit, Michigan.

In a statement to the writer summarizing her experiences and philosophy of education and science teaching, Doctor Billig wrote the following:

Through the years, my work has been related to the teaching of science in elementary and secondary schools and to the preparation of science teachers. The last 26 years have been spent in Detroit, Michigan. My duties in Detroit were two-fold. As Supervisor of Science in Elementary Schools, the work was directed toward the development of a science program. As professor of Science Education and Chairman of the Science Education Department, Wayne State University, my responsibility was to develop a program for the preparation of prospective teachers of science on elementary and secondary school levels. The Detroit schools presented a new challenge. The elementary schools are organized on the platoon plan with specially prepared teachers in various areas, such as music, art, social studies, and science. Each of the special subjects is taught in a special room in the platoon schools. In non-platoon situations, the classroom teacher teaches the science.

The development of teaching programs in the elementary schools of Detroit and in the Science Education Department of Wayne State University was guided by a philosophy that may be stated simply in the following way: Out of the environmental experiences of young people in a rapidly changing world arise many problems, questions, and sometimes only curiosities that present new problems to the teacher. She needs to do something about them. It is her responsibility to help pupils analyze and work out their problems, to help answer their questions, and to help satisfy their curiosities. The teacher is concerned with helping pupils to be more intelligent in their thinking and more secure in their reactions to situations in which science is significant. The teacher who knows young people and their environment is sensitive to their particular needs and will adapt the science work to meet them. It is believed that the teaching materials should be directed in such a way that they suggest situations in which children have opportunities to gain

science facts and understandings, and make interpretations that will help them to live more satisfactorily and securely. They should be organized in such a manner that opportunities are provided to help develop and use democratic ideals such as cooperation, honesty, respect for another's point of view and the scientific way of thinking, working, and acting. Young people should have an opportunity to develop and use patterns of behavior, of feeling, and of thought that are essential to a people living in a democratic society.

It is believed that teaching materials should be organized around centers of interest and significant experiences. These materials should be organized in such a way that understandings are enlarged by new relationships and associations as pupils pass from one level to another.

The laboratory in both elementary and secondary schools should be thought of as a place permeated by the spirit and atmosphere of a constantly changing environment. It is a workshop in which opportunities are provided for giving experiences with various types of biological and physical materials, the degree of specialization depending upon the level of attainment. It is a place where pupils may work out their science problems, and a place where they find sympathetic understanding of their interests and needs. In such situations pupils find opportunities to talk about their problems, to experiment, to try out, to observe, to draw conclusions, to read what other people have found out about their particular problems, and to apply what has been learned to their own daily living and thinking.

It is believed that the work in science should be directed toward the development of values that are important in a society such as we live in today. An experience program in science may help to develop values, such as the following:

Habit of using elements of the scientific method of work.

Understandings that are important in solving problems, answering questions, and satisfying curiosities.

Useful skills and techniques.

Appreciation of work well done.

Desire to conserve intelligently the beauties and resources of the environment.

Interests and curiosities in areas that give greater understanding, satisfaction, appreciation, and pleasure in the world.

Interests, hobbies, and activities that will carry over into leisure time activities.

Ability to work in groups which helps to develop courtesy, cooperation, friendliness, industry, tolerance, and ability to work together happily and harmoniously.

Resourcefulness.

Patterns of behavior, feeling, and thought essential in a democratic society.

To help develop the above suggested values, pupils will engage in a variety of activities, such as:

Experimenting.

Demonstrating as individuals, in groups, and in cooperation with the teacher.

Constructing.

Recording.

Interpreting.

Taking notes.

Reading for a purpose.

Manipulating equipment.

Listening.

Asking questions.

Answering questions.

Discussing.

Gathering data.

Reporting.

Arranging bulletin boards and displays.

The major purpose of the Science Education Department of Wayne State University is to prepare science teachers for their work in elementary and secondary schools. Many courses are offered, also, for other groups of students, such as the following:

Students in pre-teaching programs in

home rooms, social studies, health education, art, and music.

Students in occupational therapy.

Students preparing to become recreational leaders and camp counselors.

Students who are in-service teachers and who take work either on the University campus or in off-campus centers.

Students not interested in becoming teachers but who take work in the Department to become more familiar with their biological and physical environment.

Students in graduate programs.

In all courses in the Science Education Department, the direct experience approach is emphasized. The academic background is secured through courses in the Liberal Arts College. Education courses are taken in the College of Education. The science work offered is always in a state of flux. This is necessary in order to meet the changes brought about by the rapid development of science.

Student teaching, an important function of the Science Education Department, is done in the elementary and secondary schools of the city of Detroit. Students work under the direction of skilled science teachers and under the supervision of members of the staff of the Science Education Department.

The writer first became acquainted with Dr. Billig during graduate study at Teachers College, Columbia University. We were working toward our Doctor's degree and were in several classes together. She is one of the first four N.A.R.S.T. members with whom I became acquainted. Through the intervening years she has been a valued friend and one of the most staunch and loyal supporters of N.A.R.S.T. and *Science Education*. Dr. Billig was the only woman stockholder among the group purchasing *Science Education* from its first Editor, the late Walter G. Whitman. Thus Dr. Billig supplied financial and professional aid to *Science Education* in its most critical period. She was one of the early group concretely promoting *Science Education* along with S. Ralph Powers, Gerald S. Craig, Charles J. Pieper, Earl R. Glenn, and the writer.

During the thirties and forties Dr. Billig was a constant and tireless worker in N.C.E.S. and N.A.R.S.T. Along with the late W. L. Eikenberry, the first N.A.R.S.T. president, Dr. Billig is the only person to have served three terms as N.A.R.S.T. president. The only other woman president of N.A.R.S.T. is Dr. Betty Lockwood Wheeler who, along with Elliott R. Downing, were the only ones to serve two terms as N.A.R.S.T. president. Probably no other woman member has equalled Dr. Billig in her contributions to N.A.R.S.T. nor is held in higher esteem by its leaders. Dr. Billig has served science education devotedly, modestly, financially.

Upon her retirement from Wayne State University in 1957, Dr. Billig retired to her home at 2008 Melrose, Rockford, Illinois. Nearby she has a farm on which she has been presently modernizing some of the buildings. Now Dr. Billig plans to resume to some degree her once busy activities in N.A.R.S.T. and science education, activities once interrupted by her mother's serious illness and need of attention.

In NARST, Dr. Billig has the following three firsts:

First woman elected to NARST

First woman vice-president and president of NARST

First NARST woman to receive Science Education Recognition Award.

Dr. Billig, distinguished science education leader, richly deserves the accolade as N.A.R.S.T.'s best known and well-liked woman member. It is with pride and honor that Dr. Florence Grace Billig is made recipient of the Twelfth Science Education Recognition Award.

CLARENCE M. PRUITT

THOUGHTS ON THE EDUCATION OF SCIENCE TEACHERS FOR TODAY'S SCHOOLS

Laura Zirbes
Ohio State University, Columbus, Ohio

When I spoke at a recent meeting in the East, I was introduced by a former Ohio Stater. When she met me before the meeting she said, "Give me the low-down on you, I've got to introduce you." Having experienced some long and painful introduction, I said, "Why don't you just tell them that I'm a teacher? That's what *they* are." I added, "That will cut the distance between me and the audience, and that is what an introduction should do." So she got up and said, "I'd like to introduce the speaker decently, but she wants her past kept dark." Since then, I don't try to help people who are expected to introduce me. With the F.B.I. around, one should certainly expect to get into trouble by trying to keep anything dark. I suppose the very fact that one of my own colleagues gives me a complimentary introduction indicates that we have a pretty good time getting along together here. The fact that Dr. Cahoon is in science doesn't keep him from being in education, and that is where we are together. In the last analysis, that is where we all meet. We are together on the educational front, and we need each other, although sometimes we do not like to acknowledge it. Furthermore, as you of all people know, the field of science is so wide, and the field of education is so wide, that none of us can be specialists in everything, and so we try to achieve the breadth of outlook which dignifies our work by relating ourselves to one another, to others, in a productive, cooperative, relationship in which we supplement each other's shortcomings, instead of suffering insecurities and inadequacies from them. I want you to know that I am no specialist in science. I am not going to pose as one. If there is anything I want to know in science, I happen to be lucky enough to be at the University, where I can refer to people who have specialized in science; but I do have a specialization, and they know that. They are just as likely to come and ask me about things that I know quite a little bit about. They are also aware of the fact that our educational specializations rest on other people's specializations as foundations. Education is based on social sciences. I belong to a campus discussion group in which there is a sociologist and an anthropologist, and a psychologist and an artist, and an educator. We meet every week, and we don't like to miss those meetings. I, for one, feel that our group discussions are my chance to tap offerings in anthropology, sociology, psychology, and art, that enrich education, and *their* chance to see that education is interested in using the foundations which they are building. We sometimes get things clarified in our discussion which would be hard to interpret without putting our backgrounds together. Now if I, as a specialist in education, with a higher specialization in two aspects of it—elementary education and teacher education, with the teacher education sharpened toward the education of *elementary* teachers—if I come to you, I come as a specialist who has a great deal of interest in what science can do for teachers of children, and what science should be expected to do for all American children, not just the potential Einsteins and Edisons. What I am asking is, what is there in science which is essential and vital to the general education of American children? Then, if I go on from there, I would like to take what I am thinking about children as a basis in talking to you. You are educating science teachers farther along, whereas I am interested in the education of those persons in the elementary school as children and in the

education of people who will teach children. Young children today develop readiness for the study of science in entirely different experiences than some of you or some of us used to have. I am going to deal with three different aspects of the question, as I see it. *One* is the changing conception of knowledge itself, or science as you call it. *Another,* the changing conception of children who are to be taught; and *another,* the changing conception of education and of teacher-education which we should put with those first two. Whatever fixed ideas of prejudices you may have on that subject, will you, as good scientists, please hold them in abeyance, and at least listen to what I say as a hypothesis? Afterward, you may wish to challenge or criticize it, but please do not criticize a priori. That is something I can expect from you as scientists that I would not expect in certain lay audiences.

This is an interdisciplinary meeting of minds and I seem to gravitate toward interdisciplinary discussions. They keep me from getting down in a groove. Somebody has said a groove is just like a grave, only it isn't as deep *at first.* At one of my recent interdisciplinary contacts, somebody referred to a scientific idea which someone else had cited as "eighteenth century stuff." At that a person who was present replied by saying, "Well, *science* is *science.*" Now, is it? I mean, aren't the conceptions of the nature of science changing? I think they are, and I like to check this with you, because I am going on with this hypothesis and this assumption, unless some of my good friends that have specialized in science say, "Oh no, don't say that any more! That isn't true." My conception is that we used to think of science as organized, collected knowledge; as tested information to be transmitted as a sort of a heritage, and we used to put it into books and divide it up into chapters and lessons, into courses and segments of courses. *Units,* not the kinds of units we talk about in elementary education, but another kind—units of subject matter. And then what we used to do was see what we could do with a unit, it being a body of subject matter organized in advance. There it is, finished, all preorganized, all set down, to be assigned, read, studied, and learned. It very likely starts with definitions, because that is logical according to the eighteenth century idea. Sometimes there are people who seem to have lived through the eighteenth century into the twentieth, bringing ideas along, their eighteenth century ideas into twentieth century discussions. They maintain that science *is* an organized, collected body of knowledge which only experts have the right to define, and which teachers are then supposed to take as they find it in textbooks, and put children through, so that they can say they have "covered the subject."

The next adjustment in the conception of science education was perhaps a nineteenth century adjustment. Science was wonderful; that to give learners an awe-inspired notion that science was going to save the world—not blow it up. Those who reacted against this conception put the emphasis on the collection of facts and on other things which scientists did, so that in a sense, students would come to know the *method* of science, as observation in detail, inference from accumulated observation. In that sense, learners went through the motions, and were scientific in method, so to speak, although what they did didn't make much difference to anybody except to the person who earned his salary putting people over that ground.

More recently, another proposition became current. It proclaimed, "There is so much to science that you can not do it all! School texts must present the whole array of major concepts, abstractions and big ideas, and teachers must see that every child gets those." Well, that wasn't so bad before we knew about children and what they were, but the least nutritive item in a science diet for a grow-

ing child is a ready-made abstraction. No matter how great those great ideas are, they are not likely to be assimilated when purveyed to children *ad seriatum* as great ideas. They are apt to be verbalisms which have very little meaning, and very little likelihood of carrying over.

In order to adjust the approach to children, early in the current century we made demonstrations that were supposed to lead up to the big ideas, to make them attractive with a little of what one youngster called magic, that went before. I'll never forget how one of Dr. Power's Teacher's College bright young men working in our summer school did that before observers, on the assumption that his demonstration lesson was not only teaching children science but demonstrating good science teaching to the experienced teachers who were observing. The children were in the special class for slow learners. He was using water in a demonstration which was intended to lead up to a direct inference—an abstracted idea—a conclusion from observation not a *generalization* in the sense that the children had generalized, for the children had only the *one* staged demonstration—one special case on which to base inference. They watched him with their eyes, ears and mouths open as he used a glass tube to lift a drop of water from a glass tank, transfer it to a slide, and put it under a miscroscope. They put their eyes to the microscope at his direction and were horrified to see squirming creatures where they expected to see nothing but a clear drop of water. He then put a few drops of an unnamed chemical from a small bottle into the tank of water, and that turned it blue. After stirring the blue water, he lifted another drop to a clean slide, inserted it under the lens of the microscope and directed the children to look again, in turn. Then he said, "What does this prove? One child said, "That you've got magic!" Now magic is the very antithesis of science. To the children, the demonstrator seemed to have conjured up weird animals, turned water blue, and disposed of the animals, if indeed that much of a sequence of events had been noted. He *acted* like a magician. The performance was a mystery to them—not a proof. The children reacted as people do when they are confronted with staged demonstrations that do not demonstrate but mystify; with expectations for which they have no readiness; with ideas that do not communicate because the *meanings* are not conveyed or developed; with abstractions that have not been *abstracted by* and *with learners* from the *concrete* contexts of their own meaningful experience, with generalizations which are in fact only pseudo-generalizations, because they are purveyed and received as ready-made verbal formulations without being derived in a quest for the general or common significance of factors noted in an array of particular instances. It is this *process* of *generalizing* which should be guided so that particular experiences become the stuff of ever more discriminating comparison, conceptualization, inquiry, and tested inference. That process is what science teachers should learn to foster and facilitate, but they must also learn that the process cannot be reversed, rushed or shortcircuited without violating the very conditions and values on which the development of scientific attitudes and insights depend. The approach which seeks to cover the whole scope of science by such demonstrations is systematically designed to take children over the ground, but it does not do what science education should do to develop children.

With access to new insights into child development and learning, it became clear that there must be an experience approach; that the child's own questions and observations must be the point of departure for inquiry and active involvement, that the scientific quality of the experience is contingent on the challenge to inquiry and inference on the child's discovery of significant relationships, on the development

of sound insights and attitudes; that all this must be integrally related to ongoing experience to have carry-over value for living and further learning; that the ground cannot be covered except as the implications of science for living constitute present ground; that the recurrent challenges of widening experience and increasing maturity provide the opportunity and responsibility for educative developmental guidance. This is not tantamount to following children's interests wherever they wander. It is rather a commitment to develop scientific insights and attitudes as a concomitant to expanding areas of living. Life is complex and is a continuous challenge to inquiry and insight. Science education which adjusts to the developmental level of the child's inquiry about ongoing experience sets itself quite a different task than that reflected in the formal demonstrations and systematic presentations of textbooks and courses of study that treat science as a separate subject. We are no longer under the illusion that the approach of the subject matter specialist is suited to the developing child. The approach must develop readiness, it must fit the mental grasp of children who are not and may never be science specialists, but whose everyday lives are nevertheless bound to be influenced and permeated by science at every turn. The thoughtful educator comes to see that teaching and learning must start with what Hadley Cantril refers to as "The Why of Experience."

But education is not the only area in which twentieth century thinking and study have caused change. At the same time, the concept of science itself has been changing, so that it is no longer conceived as a highly organized body of collected knowledge as viewed by specialists, but more or less as a study, as a way of coming to understand why things happen as they do, what man can do with natural resources, what we can use to live by, how we can be more intelligent about living, so that we are not deluded as often or as easily, so that we can predict, in other words, in terms of known causes and effects, and plan and act accordingly. All this gives science a vital role in general education. One of the outstanding ways of recognizing that role is the study of conservation or the study of the use of resources. Science insights enable us to conserve what we have to use so that waste is reduced and life is enhanced. In the southern parts of our country, a great deal has been done to use this as an organizing approach to curriculum advance concerned with the improvement of living through education, as an approach to community study and to regional advance. None of these areas of study are school subjects or academic subjects, you notice, but they are all themes that have much to do with science and with the improvement of living. Life has to be seen as community life, as regional life, as work life, as leisure life, as life in which all the relationships are either stablized or equilibrated, so that life can go on with perspectives that take the past and the present and the future into account, so that the resources or the where-with-all for living may not be exhausted. Now, a great deal of that can be assimilated without the systematic introduction to each separate field of science in a text.

Interestingly enough, what we were learning about *children,* and what psychologists were learning about *learning,* also had scientific implications for *teaching* children, and for teaching children *anything,* science included. You teach when children are helped to learn by the way you put those things together, not otherwise; when you as a scientist get interested in how people *learn,* and how they develop, and how they *live* in a society, you get a different answer to what you do in a school, and you get a different challenge to do what you do *to make a teacher.* I don't want to talk about teacher *training.* Training is only part of the process and not the most important part. You *develop* teachers, you *educate* teachers, you *inspire* teach-

ers, you *inform* teachers. Yes, and if you simply *train* them, you go about giving them fixed ways or habits. The world is moving too fast to make that very safe. New knowledge comes in, new insights, new problems; mere training is too apt to make people fit into a groove of past habit and past ways of doing, instead of making them alert to the changing situation in which they find themselves, to the new knowledge which is developing, to the relationships between the fields in which their lives are involved. Consequently, the *development of teachers*—the development of a teacher of any level, or of anything, any field, science included—must sensitize the person to the life-relatedness of that field. I should say that you should not begin with one little corner of it specialized and called something that a specialist calls it, but just as you in the high school have put general science ahead of specialized science, so a teacher of children and youth should see how science is life-related, and should provide experiences in the community, in life, which give children a growing realization that modern life is science-related. That means field trips that have to do with living experiences in which the student can be sensitized to the life relatedness of science, and the science-relatedness of that phase of living into which his teacher is taking him as a guide and interpreter.

The study of conservation or intelligent resource use might well be a good approach to science in general education. A prospective teacher who is started that way is more likely to see that it makes sense with children or with high school youngsters to let them see the human bearings of things before they get the facts and the abstract knowledge. If I were talking to a group of mathematics teachers, I would say the same thing to them. I think many teachers do not realize the life-relatedness of mathematics. They think of mathematics as a subject, its processes as skills. I think there are mathematicians among you who would grant that it is important to develop a sense of the life-relatedness of mathematics; to realize that you don't do much of anything in which mathematics hasn't functioned, and in which it cannot function to enrich experience and contribute to living. A great many people have learned how to evade mathematics, how to be blind to it, and I think sometimes our overspecialized education does that to people. It shows them how to learn what is in a book without any interruption or interference, and how to carry it to the final examination and deliver it there and get a grade, and then forget it. All they have left is a certificated record that they don't have to do it again. Now if life-relatedness starts the education process, then I think we can also hook mathematics and science into life so that they go on enriching life and functioning in developing lives. Trips into the community show children how science functions in the waterworks, in the dairy, on the farm and in the city, in their own affairs. If that is not a scientific approach, I don't know what is. Causes operate in the lives of children. A fifth grade was making candles in a study of colonial life, but their candles did not "wax" or grow thicker. The teacher said, "Isn't it time to sit down and think?" One yonngster said, "No, let's go on dipping, dipping, dipping!" And so the teacher let them go on dipping, dipping, dipping a little longer. They went around and around dipping as they went, but still the candles did not "wax!" Finally, one youngster said, "I think we should sit down and think." That was science. When blocked in a problem in life, whatever it is, sit down and think. Soon one child said, "I bet I know what it is," and he came up with a probable cause of the difficulty. Almost immediately another child said, "Come on; let's try it and see if that is it." As I remember it, this child's idea was that the water on which the wax was floating was not hot enough. They turned up the gas. That

was the variable according to this child's guess, bet, or hypothesis. After the heat had been turned up, they went around again, dipping and dipping. Still the candles did not wax! They could see that the idea was not good. Somebody said, "Let's think again." Many adults would give up, or ask somebody instead. Thinking is a better plan in life's dilemmas. This was a life-related problem. Soon someone came up with another suggestion, "Maybe we should turn the gas *lower* instead of higher, and wait awhile." Another said, "Let's get a thermometer and see how hot it is *now*." Precision! After a while, one of them looked at the thermometer again and said the heat was going down. "Let's try it now," proposed another, a little impatiently. Somebody suggested that they go out and play a while, letting the liquid cool, and then come back. They went and when they came back, they went around again. Still the candles did not wax! Finally, one little fellow said, "You know, it could be more than one cause. A lot of things are due to more than one cause, and I was just thinking it could be how fast you dip, *and* how hot it is, *and* how long you keep it out before you dip again." Talk about multiple causation! Here it made sense to children. They set up a little experiment right there, in which they decided to dip *faster*, to keep their candle strings out *longer* before they dipped again, and to see what happened. And I think that one of the most glorious memories I have is the one of those youngsters when they discovered that they had it! They had solved the problem! But really, they had solved more than that problem. Three or four times long afterward, I heard them use what they had gotten as a general "hunch" from that experience: "Could be like the candles." "Maybe there's more than one cause," which was a very important idea. Or they would say, "Well, I guess this is one of those times when we'll have to experiment." One day they were reading about silkworms. But silkworms and candles have nothing to do with each ther, do they? One is biological science and the other is physical science. But there was a carry-over which bridged the gap, when these children were reading about silkworms. They read in one book that the winged insects broke out of the cocoons about ten days after the silkworm had finished spinning. In another book, the time was given as approximately two weeks, a third book said ten or eleven days. The discrepancy bothered the children. One asked, "Why don't they get it down pat before they put it into a book?" Somebody said, "I was just thinking, it could take longer in some countries." "Why," asked another, "what does a country have to do with it?" Comments about the possible effect of climate came thick and fast, and then someone proposed that the whole matter could be decided by experimenting. The children realized that their experiment might not settle the problem about silkworms everywhere but that they could keep a record and find out for themselves just how long it took if they got some eggs, waited for them to hatch, watched the silkworms grow and spin cocoons and then counted the days that passed until the cocoons broke open. This was a longer test of patience than the candle experiment but the children entered into it and carried it through. They came out with more science learnings than they expected or realized. They had to find out about the rest of the life cycle of the silkworm, about its habits and its needs. They had to locate some mulberry trees and arrange for cutting twigs. They had to find where they could buy silkworm eggs and order them. They had to plan ways of keeping a record of their observations and a diary account of the whole experience. They had to plan in advance what to do about weekends. They were surprised to find that some of their eggs did not hatch, for the books did not mention that possibility. They noted that some

worms began to spin sooner, that some took longer to spin than others. It was difficult to make sure about the number of days for each individual worm, but they worked it out. The first cocoon broke ten days after it had been spun. Others took eleven or twelve days, but some did not break at all. The children ran into a whole array of examples of individual differences, even though their worms had looked alike. They learned about averages and other measures of central tendency, about approximate time and the difficulty of being precise, about the percentage of eggs that hatched and the proportion of cocoons that did not break. They learned all these things by facing the problems that arose in the course of their experience, and they learned them so that they carried over. Long afterward in referring to what a news account said about "the average soldier" they said, "Remember now that's an *average,* not a particular fellow." You and I know how scientific illiteracy causes people to have the mythical concept of the average child, to assume *one* cause, and to draw conclusions from the mass handling of data without any allowance for individual differences. There are many more of those myths and notions by which people live who have not been exposed to the scientific way of testing their hunches and solving their problems and coming to conclusions which they have validated in action. So I should say that at any level, life-relatedness should be the approach, and that gradually we should show the child and the student, that when the information you come out with gets to be voluminous you classify it and organize it in order to handle it and keep it in order; that eventually you organize different kinds of scientific data into specialized, separate fields and subdivisions of special fields, and that there are people who specialize in finding out more and more about some specific phase of science. But to start them *without* that general life-related base, makes them more or less unaware of what Lewin, the psychologist, called "the field," in which the facts and findings of science are dynamically related. It makes them unaware of the carry-over possibilities to many life situations in which the sciences are not isolated. There are a great many life situations in which there is a combination of the physical and the organic. When a life problem is faced, it often has to be tackled without primary concern about specialization, and with an insight into field relationships. Knowledge itself, therefore, suggests that we not take a fragment and assume it to be a whole; that we see to it that relationships are maintained or opened up, so that people have ways of keeping from being too specialized, keeping from thinking that all knowledge of anything is within the bounds of a particular specialization.

Young folks who are going to teach in the elementary school or the secondary school are handicapped by the university conception of undergraduate science courses as vestibules leading directly into specialization in science on graduate problems. I wonder if we are not leaving young people with subject-matter knowledge that has no use except for course passing, for final examinations, for college credit. I wonder if we are not leaving them uninspired, and unilluminated by the wonderful things which we can get by comprehending what the human mind can do by keeping eternally at problems that challenge inquiry. If we have too much respect for what scientists *have done,* for the experts as experts, for the education of science specialists, what happens to the education of others, to the science outlook of the developing citizen as science has bearings on it; to his inquiries into the human bearings of science on the life and work of man?

Taking the tempo of human affairs into consideration, it seems that science is going to have a greater responsibility than ever in developing the tendency to inquire, the tendency to explore, the tendency to respect "freedom to explore" as Norbert

Wiener states it. To raise human life and aspiration to its highest potential, we need freedom to explore, and a sense of the significance of exploring beyond what we know; a sense of the way to explore to extend human knowledge, and a sense of respect for what other people have discovered. Everyone needs the combination of attitudes, concepts, and insights conducive to freedom from ignorance, superstition and unreasoned fears. Everyone needs consumer understandings about the specialized science fields, and those who guide or teach children and youth need a science orientation which differs from that of the persons headed for science specialization. Those who are headed toward teaching or guidance also need more insight into the science of human growth, development, learning and adjustment. Children are still developing when they enter high school. Many of the things teachers don't understand about thirteen and fourteen year olds, would be understood better if they understood child development. Insight into the nature of the individual and the nature of groups, enable teachers to pace learning and guidance to the learner's level instead of becoming responsible for failure by failing to do so. Knowledge about human development is every bit as specialized and respectable as any branch of science taught in schools. There are tomes of new knowledge on human development, on human attitudes, on human limitations at various levels. And anyone who is going to teach *people,* whether he intends to teach science, literature, or anything else, needs to inform himself, needs to equip himself with insights into development, into the nature of learning, into the nature of society and its problems, and into the role of science in life today—but also, into the art of teaching which applies and integrates these insights. That means that everyone who is going to teach science must be protected from falling back on the way he was taught, must have some kind of an exposure to the method of fostering inquiry, as the modern method of science teaching, the method of cooperative thinking. He must somehow or other learn not to assume that the questions and answers are all in the book, and that the teacher merely assigns, knows, and tells. He must conceive of the teacher as the person who develops children's capacities for inquiry, so that they become more and more responsible and more and more independent inquirers and not just persons who expect to have answers handed to them. When a youngster looking at a candle says, "Why did it go out?" It is so easy to just say, "Be quiet," or "I will tell you all about it." It is much more difficult to find the art of having the child *find* out why the candles went out. Interesting propositions are constantly coming up in which children need to be guided by people who know the way of finding out, and who also know how to help children along that way, to show them resources that can be used to make the simple laboratory facilities for active learning available. I am not referring to standard laboratory equipment nor to textbooks or encyclopedias although they all have their place. There is a helpful new pamphlet entitled *Science for Children and Teachers.* It is by Herbert S. Zim who is one of a number of science educators whose materials indicate that he understands children and knows how to make science a life-related, developmental challenge to them. Prospective teachers will catch the spirit of that by contact with materials like this, by noting the suggested resources which would enable any teacher to do a better job in relating science to life. Even on high school levels, particularly with subject-centered or textbook-centered instruction, it helps to use the problems and materials of everyday life involving pupils in the homely experiments which bring science a little closer to their interests and give them the challenge to discovery and inference.

A student was telling me about some youngsters who wanted to know how a

dam worked. I said, "What did you do?" Her answer was, "I told them." My disappointed look made her ask, "What was wrong with that?" I did not *tell* her, but I helped her to find out, and to realize why *telling* was not as good as what she might have done. Prospective teachers need information nevertheless, but information which enables them to restrain the impulse to *tell* what children can be guided to *discover* and share with their classmates through active inquiry, observation, or experiment. Prospective science teachers need many guided opportunities to work with children in such activities. Even when science methods courses provide opportunities for prospective teachers to do such things themselves, as individuals or in groups, there is need to realize that this may incline them to direct children's activities in terms of what *they* have *done* in their course work, or to do much or all of the planning and work themselves. This obviously reduces the science values to the children greatly.

Prospective teachers need to have the values and value potentials of children's science activities made explicit to make sure that their practices give children access to those values. This is only one safeguard against formal, sterile, didactic teaching. Somewhere in their preparation, students need to explore the educational possibilities of trips which are rich in their potentialities for special aspects of science at various levels.

Prospective teachers also need experiences in student-teaching which enable them to see how science values may be related to other curricular values in the school day. As student teachers, they need experiences in sharing discussions of common problems with other students and in evaluating various aspects of their own work, viz., (1) their responsiveness to children's science needs, (2) their sensitivity to the science potentialities of children's comments and questions, (3) their use of experiences, resources, and materials through which the science interests of individuals may be developed and the science learnings of classroom groups may be enriched. It is through constructive guidance based on such evaluations that prospective teachers may be helped to integrate their preparatory experiences with increasing competence and confidence, and develop readiness for further growth in service.

1959 NARST MEETING

The 1959 NARST meeting will be held at the Hotel Dennis in Atlantic City, February 19–21. The Council of Elementary Science International will meet jointly with NARST on February 21.

ROBERT K. WICKWARE

The President of the Association for the Education of Teachers in Science during 1957-58 was Dr. Robert K. Wickware. He had served as a member of its Executive Committee during 1954–55. Dr. Wickware was born in Bison, South Dakota, August 12, 1913. He attended elementary schools and graduated from the school at Valier, Montana. He received an A.B. degree from the University of Montana, Missoula, Montana, in 1934. An M.A. and Ed.D. degrees were earned at Columbia University in 1940 and 1947. The title of his doctoral study was *Developing Science Education with Regard for the Regional Community of Eastern Connecticut.*

He married Mary Plantereth and they have two children Sara Elizabeth (Sally) age ten and Jane Isabel (Janie) age four. He is a member, Senior Deacon, and Trustee of the Congregational Church.

Teaching experience includes Valier High School, Valier, Montana, 1934–35; Lewistown Junior High School, Lewistown, Montana, 1935–39; Assistant in the Department of Natural Science, Teachers College, Columbia University, 1939–41; Willimantic State Teachers College, Willimantic, Connecticut, 1941 to the present. During 1951–1952, Dr. Wickware was on leave and taught during the fall semester at the University of Hiroshima, Hiroshima, Japan, and during the spring semester at the Tokyo University of Education, Tokyo, Japan. At both of these institutions he served as Consultant in science education. Summer session teaching includes: Co-director of Elementary Science Workshop, University of Connecticut and Visiting Professor Danbury State Teachers College, 1954; Columbia University, 1955; Elementary Workshop Director, State of Vermont, 1957; Consultant San Jose State College, 1957; Consultant on TV Program, *Asia In Ferment,* Connecticut State Department of Education, 1957.

Membership in organizations include N.A.R.S.T., N.C.E.S., Phi Delta Kappa, Kappa Delta Pi (Counseler, Epsilon Nu Chapter), N.E.A., N.S.T.A., Connecticut Education Association, Connecticut Science Teachers Association, A.A.A.S., A.E.T.S., A.A.U.P., American Association for the United Nations-Lecturers Service, Connecticut Council on Teacher Education.

During 1948–49 he served as Treasurer of the National Council for Elementary Science. He was chairman of the International Relations Committee, member of the Evaluation Committee for Packet Service, and member of Nominations Committee, of N.S.T.A. 1957–58.

Published articles include Science Teaching and Creativity in *Educational Leadership.* December, 1952; Science Education in U. S. in *Journal of Japan Science Education Association,* Tokyo, Japan, April 1953; Reflections on Working in Japan in

Social Studies Topics. Fall 1953; Some Reflections After Working with Japanese Educators in Their Native Country, *Teacher Education Quarterly* Spring 1954; The Science Program at Willimantic State Teachers College in *Science Education,* March, 1955; Integration of Science Learnings Through Regional Study Four in *Science Counsellor,* June 1955; Securing Materials for Experiences in Science for Children in *Metropolitan Detroit Science Review,* April, 1958; and Framework for the Elementary Science Program in *Elementary Principal,* April, 1958.

Publications include *Science Education in Japan* (3 Volumes) Consultant, Ministry of Education, Tokyo, Japan, 1951–52, Institute for Education Leadership and *Developing Science Experiences with Children,* to be published by Wadsworth Publishing Company, San Francisco, California, March, 1959.

CLARENCE M. PRUITT

ASSOCIATION FOR THE EDUCATION OF TEACHERS IN SCIENCE

TEACHERS COLLEGE, COLUMBIA UNIVERSITY, NEW YORK 27, NEW YORK

FALL 1957 MEETING

OCTOBER 31, NOVEMBER 1 AND 2

CONFERENCE THEMES

October 31—SCIENCE EDUCATION AND THE INTERNATIONAL GEOPHYSICAL YEAR

November 1 and November 2, FOUNDATIONS OF SCIENCE EDUCATION

OFFICERS

President: Robert Wickware, Willimantic State Teachers College, Willimantic, Connecticut.

President-elect: June Lewis, New York State University Teachers College, Plattsburgh, New York.

Vice-president, East: George Zimmer, New York State University Teachers College, Fredonia, New York.

Secretary-treasurer: Willard Jacobson, Teachers College, Columbia University, New York, New York.

EXECUTIVE COMMITTEE

F. L. Fitzpatrick, Teachers College

Frank X. Sutman, Inter-American University, San German, Puerto Rico

John Wells, Madison College, Harrisonburg, Virginia

CONFERENCE REPORTER

Tracy Ashley, Great Neck Public Schools, Great Neck, New York

THURSDAY, OCTOBER 31

ROOM 256 THOMPSON HALL

SCIENCE EDUCATION AND THE INTERNATIONAL GEOPHYSICAL YEAR

Chairman: Robert Wickware, President A.E.T.S.

9:30–10:15 Registration and Coffee Hour

10:15 Welcome—Frederick L. Fitzpatrick, Head, Department of Teaching of Science, Teachers College, Columbia University.

10:30 "Science Teaching and the International Geophysical Year," Thomas D. Nicholson, Associate Astronomer, American Museum-Hayden Planetarium.

12:00 Lunch.

1:00 Leave for field trip to New York Laboratories of the Atomic Energy Commission, 70 Columbus Avenue, New York.

FRIDAY, NOVEMBER 1

ROOM 256 THOMPSON HALL

FOUNDATIONS OF SCIENCE EDUCATION

Chairman: Robert Wickware, President, A.E.T.S.

9:00–10:00 "Science and the Social Development of Children," Lorene K. Fox, Queens College.

10:00–12:00 Group Meetings.

Group I. The History of Science and Science Education as a Foundation for Science Education, Room 200 Horace Mann Building.

Discussion Leader: Gordon Manzer, Trenton High School, Trenton, New Jersey.

Recorder: Frances Hall, Barnard College and Teachers College, Columbia University, New York, New York.

Extension Reporter: Fletcher Watson, Harvard University, Cambridge, Massachusetts.

Discussion Resource:

People: Leo Klopfer, Regional High School District No. 8, Hebron, Connecticut; Louis I. Kuslan, New Haven State Teachers College, New Haven, Connecticut.

Group II. Child Development as a Foundation for Science Education, Room 202 Horace Mann Building.

Discussion Leader: Paul Blackwood, U. S. Office of Education, Washington, D. C.

Recorder: Jewell Burgner, Great Neck Public Schools, Great Neck, New York.

Extension Reporter: John Garone, New York City Public Schools.

Discussion Resource:

People: Jessie Wall, University of Connecticut, Storrs, Connecticut; Helen Warrin, Newark Public Schools, Newark, New Jersey; Harry Milgrom, Supervisor for Elementary School Science, Board of Education of the City of New York.

Group III. Adolescent Development as a Foundation for Science Education, Room 203 Horace Mann Building.

Discussion Leader: Robert Gifford, Baltimore County Public Schools, Baltimore, Maryland.

Recorder: Peter Dean, Teachers College, Columbia University.

Extension Reporter: Alfred Beck, Division of Junior High Schools, Board of Education of the City of New York.

Discussion Resource:

People: Henry F. White, Fordham University, New York, New York.

Group IV. Our Society and Its Needs as a Foundation for Science Education, Room 205 Horace Mann Building.

Discussion Leader: Charles Prewitt, Willimantic State Teachers College, Willimantic, Connecticut.

Recorder: Hugh Allen, Montclair State Teachers College, Montclair, New Jersey.

Extension Reporter: S. R. Powers, Teachers College, Columbia University.

Discussion Resource:

People: Harold Tannenbaum, State University Teachers College, New Paltz, New York; T. B. Hayre, State Teachers College, Cheyney, Pennsylvania.

Friday, November 1

Room 256 Thompson Hall

12:00–2:00 Lunch: Teachers College Cafeteria. Dining Room A, B, and C.

Address: Child Development and Its Implications for Science Education. Roma Gans, Teachers College, Columbia University.

2:00–5:00 Group meetings. (Same rooms as used in morning meetings.)

5:00–6:00 Meeting of Officers and Board of Directors, Room 412 Teachers College Main Hall.

6:30 Dinner. Men's Faculty Club, 117th Street and Morningside Drive, New York.

Chairman: George Zimmer, Vice-President, East.

Address: History of the Teaching of Physics in American Schools. Ned Bryan, National Education Association.

Business meeting.

Saturday, November 2

Room 256 Thompson Hall

Chairman: June Lewis, President-Elect A.E.T.S.

9:00–11:00 Statements by Extension Reporters. Discussion from the Floor.

11:00–12:00 Presidential statement: Robert Wickware, Retiring President, A.E.T.S.

A REPORT OF THE FALL 1957 MEETING OF THE ASSOCIATION FOR THE EDUCATION OF TEACHERS IN SCIENCE

Tracy H. Ashley

Science Consultant, Elementary Schools, Great Neck, New York

The fall 1957 meeting of the Association for the Education of Teachers in Science was held at Teachers College, Columbia University, October 31, November 1–2, 1957 under the chairmanship of President Robert Wickware. The conference themes were Science Education and the International Geophysical Year and Foundations of Science Education. In this report of the meeting I am including a short general description of the meetings, an interpretation of the discussion meetings by the recorders, a short digest of President Wickware's remarks at the close of the last session and the minutes of the annual business meeting.

GENERAL DESCRIPTION OF THE MEETINGS

The conference was opened by a welcome from Professor Frederick Fitzpatrick following which the meeting was treated to a very informative talk on the International Geophysical year by Thomas D. Nicholson, Associate Astronomer, American Mu-

seum. Hayden Planetarium. The speaker pointed out that this isn't the first time there has been an organized scientific effort. The "Polar Years" 1883 when a concentrated effort on magnetic phenomena was made and in 1932 when scientists of the world made a study of the atmosphere. Scientists felt another world wide study was needed now because of the speed of recent scientific developments and the fact that earth science is important to all and we must extend scientific work to our entire world environment. The International Geophysical Year from July 1957 to December 1958 was chosen because of the increase in solar activity. There are 64 nations participating with a national committee.

Mr. Nicholson said there are three major areas of investigation: (1) atmosphere, (2) oceanography and terrestrial masses, (3) astronomy. Under these large areas findings are hoped to be made about such things as aurora and air glow, cosmic radiation, geo-magnetism and fields in space, glaciology, gravity-variations, earth's shape, latitude and longitude, meteorology, oceanography, and solar activity.

A lively question-answer and discussion period followed and I am sure all participants gained much valuable information to take back to the classroom.

The afternoon session of the first day was taken up by an interesting and informative field trip to the New York Laboratories of the Atomic Energy Commission.

The conference theme for the last two days of the conference centered around "Foundations of Science Education." The first half of Friday's morning session was well spent as Dr. Lorene Fox of Queens College addressed the group on "Science and the Social Development of Children." Dr. Fox used the knowledge gained through a wide experience of working with children in her excellent presentation of this subject. The speaker pointed out that children must see science in a social context. The activities that children engage in in science can come from a wider framework and children should learn science with a purpose. The teacher must keep in mind the fact that there are many minimum essentials and that good teaching is not in telling children answers but in helping them find the right answer.

The remainder of the morning session was devoted to group meetings in four areas of concern to science educators. The reports of these discussion groups made by the recorders will be included at the end of this report.

At the luncheon on Friday noon the conference was privileged to hear Dr. Roma Gans of Teachers College address the gathering on "Child Development and Its Implication for Science Education." Dr. Gans told us that it has been proven there is a tremendous language growth when children are exposed to science. Word meanings are important in science and that science does not need to be a strained language. There is a relationship between language-experience and meaning. Through science experience children use a more descriptive vocabulary and gain satisfactions with a growing, continuing interest. The speaker stressed the tremendous growth in thinking and understanding of causal relationships provided by science. Professor Gans spoke of the need for a sequence of events in the lives of children and how science provided this. Through science children substitute knowledge for fear, superstition and prejudice.

The Friday evening dinner meeting held at the Men's Faculty Club was chaired by Harold Tannenbaum. Ned Bryan of the National Education Association gave a very interesting talk tracing the history of physics teaching in American schools.

The closing session on Saturday morning under the chairmanship of June Lewis, President-elect A.E.T.S., proved to be a most valuable meeting. The extension reporters Harold Tannenbaum, John Garone, Alfred Beck and Hugh Allen, who filled in very ably for Dr. S. R. Powers, gave very succinct reports on each of their dis-

cussion groups, and left us with much food for thought.

The closing statement by Robert Wickware, retiring President, was one of the highlights of the conference. I cannot attempt here to put down all of his fine statements. I will record some of his points that I felt particularly appropriate.

The retiring president stressed a point that arose several times during the conference and that is that science must be a part of the everyday living of children. Teachers must decide what are the important parts of the environment in working with children. The speaker pointed out that there are different levels of understanding on the part of the public in regard to the purposes of science education.

Teachers of science must keep in mind:

1. The need to help children to follow through on their curiosity.
2. The need to use the forces in our environment.
3. Many of our children *do* want to become scientists.
4. The need to use wise choice in purchasing materials.
5. Recognize that children need to feel belongingness. (Mental hygiene)
6. The rapid increase in new scientific discoveries.

Dr. Wickware also pointed out some hindrances to good science teaching.

1. The change in our living conditions.
2. The stress on conformity.
3. Watching rather than participating.
4. Verbalization rather than experience.
5. The stress on the three R's.
6. Science is a rigorous discipline.

The speaker also spoke of the need for society to see their stake in science education. Parents must realize that much science learning can take place within the home. Parents need to spend more time with their children helping them to discover their environment. Children must be free to interpret and feel at home in their environment and to extend the frontiers of knowledge. It is the responsibility of young people to share this knowledge.

In closing Dr. Wickware said that teachers must be free to teach and carry out new experiences with their children. "Can we teach behind an iron curtain?"

I felt and I heard many members express the opinion that this had been one of the best meetings of the A.E.T.S.

REPORT OF THE ANNUAL BUSINESS MEETING

The Annual Business Meeting of the Association for the Education of Teachers in Science was held Friday evening, November 1.

The following officers and new members of the Executice Committee were elected:

President: June Lewis—New York State University Teachers College, Plattsburgh, New York.

President-Elect: George Zimmer—New York State University Teachers College, Fredonia, New York.

Vice-President: Harold Tannenbaum—New York State University Teachers College, New Paltz, New York.

Executive Committee: Charles Prewitt—Willimantic State Teachers College, Willimantic, Connecticut.

Willard Jacobson will continue to serve as Secretary-Treasurer and Frederick L. Fitzpatrick and Robert Wickware on the Executive Committee.

The Association moved to accept the invitation of Fletcher Watson of Harvard University to hold the spring meeting at Harvard on April 25 and 26.

The Fall meeting will be held at Teachers College, Columbia University, on November 6, 7, and 8, 1958.

It was suggested that at least one day of the Fall conference be devoted to some aspect of science. A summary of progress of the IGY program was suggested as one possibility. The membership expressed an interest in visiting either Brookhaven or the Lamont Geophysical Laboratories. Some time should be devoted to a resumé of recent research in science education, particularly

research stemming from the Science Manpower Project. Some of the research could be presented in elementary and secondary sections where there could be ample time for discussion.

REPORT OF THE GROUP DISCUSSION MEETINGS

Group 1. The History of Science and Science Education as a Foundation for Science Education.

Discussion Leader:—Gordon Manzer, Trenton High School, Trenton, New Jersey.
Extension Reporter:—Harold Tannenbaum, State University Teachers College, New Paltz, New York.
Discussion Resource People:—Louis I. Kuslan, New Haven State Teachers College, New Haven, Connecticut.
Reported by:—Frances Hall, Barnard College and Teachers College, Columbia University.

Group 1 decided that the history of science and science education was a way of helping elementary and high school teachers understand the nature and importance of science. It is especially important for elementary teachers as an aid to overcome some of the insecurity they often feel in science.

1. As background for the discussion, Mr. Kuslan reviewed the history of science education in America and pointed out that interest in history of science education is increasing, as witness recent articles in *The Science Teacher, Journal of Chemical Education,* etc.
2. When the periods in science education are considered two movements stand out:
   a. *Object teaching*—which included much Botany, Zoology, Physics, Chemistry, Minerology and Astronomy. In the normal schools much science was offered. Twenty to thirty years ago the whole normal training course was based on science. These courses were professionalized. In others the courses in science taught what they believed children ought to know. The ideas of Chemistry were presented that teachers might use later in the classroom.
   b. *Nature Study*—began approximately in 1889. Nature Study was taught more in urban schools than in rural schools.
3. Little use of the training in science in the normal schools was made by the teachers in the classroom. There was lip service to the teaching of all the science learned in the normal school since the charts and objects were purchased but they were not used to any great extent in the classroom. Most of the class time was devoted to the 3 R's.
4. Looking back on the history of science education—when from 1880–1920 (approximately) there was little application of the learning. One asks whether we have progressed today. Some science courses in teachers colleges may not be as rigorous as those in a liberal arts course. The group's answer is that we have progressed—
   1. Laboratory teaching is better now.
   2. Better texts and equipment are available.
   3. We seek for answers rather than the older catechetical form of teaching.
5. History of science teaching—1. Gives examples of scientific thinking as scientists grapple with a problem. 2. Case study method to get ideas of how scientific method can be and was used. 3. The history of science is so vast that we can go back into the history of knowledge and find material for use in teaching scientific theories. There is always something to be discovered here.

Group 2. Child Development as a Foundation for Science Education.

Discussion Leader:—Paul Blackwood, U. S. Office of Education, Washington, D. C.
Extension Reporter:—John Garone, New York City Public Schools.
Discussion Resource People:—Jessie Wall, University of Connecticut, Storrs, Connecticut;

Harry Milgrom, Supervisor for the Elementary School, Board of Education of the City of New York.
Reported by:—Jewell Burgner, Lakeville School, Great Neck, New York.

We are all agreed that science in the elementary schools will have to be much more meaningful and effective to meet the needs of the children of today. Therefore, teachers within the elementary schools will have to sit down together with the administrative staff and determine just what knowledge, methods, and materials will be needed to fulfill the following areas of concern in the elementary science program.

1. What are the goals toward which we are aiming in our elementary schools?

   To answer this question, one has to look back into the programs of the elementary schools to see if science has really answered the needs of the children in their interpretations of the how, what, where, and why of the world in which they live. Are the concepts that they are forming meaningful, or just facts to learn and store away for answers to questions during given examinations?

   After a backward look into what has been done, a look at the existing programs of elementary schools of today should be taken to see if the understandings or interpretations of the how, why, where, and what are any more meaningful than those of the past. If there is a lack of interest in working scientifically through a problem until meaningful concepts are formed, then the program should be examined very critically as to the goals set to be attained. New goals may be needed to meet the needs of the children of today so that they may be better equipped to meet the problems of a rapidly changing and expanding of the world of yesterday.

2. How much should be made of children's questions?

   Children's questions should give teachers of elementary schools the clues as to what areas of interest exist within their classes. These questions should alert the teachers to the troubling misconceptions that may be bothering students and that need clarification.

   Concepts are not formed all at one time, but are constantly changing as growth takes place. Children have to learn to test and retest their ideas before forming meaningful concepts. Therefore teachers should be led by the children's questions into areas of interest as co-worker's, as well as guiding them toward meaningful concepts that are derived from working in a scientific manner.

   Although we do consider and make use of children's questions for a meaningful science program, we must remember that an entire science program of just questions voiced by children would not be complete enough to fulfill the needs of the fast accelerating world of today with its discoveries, inventions, and space exploration. There must be an adjustable overall program planned by the teachers of elementary children. This program must make use of the fact that early concept formation is much more easily attained during the formative years.

3. How can children improve their abilities to solve problems?

   The ability of children to solve problems will improve as they develop an understanding of what they are doing. This understanding breeds well in an atmosphere of questioning, experimenting, and searching. Science interpretations in this kind of atmosphere are continually growing and expanding as new research is found, new results to experiments discovered, and new confidence in own ability is developed.

   As children expand in the number of newly learned concepts, there is a desire to find more information about areas of interest which in turn

leads to intensive research of all sources possible for additional information. More searching leads to modification of original concepts, and also leads children into new realms of learning.

In this atmosphere, the non-conformist also has freedom to explore and determine whether he is right or wrong. From many of these non-conformists of the past have come our great inventors, discoverers and men of vision. They have had insights far beyond the realm reached by the majority of people.

In an exploring atmosphere we can help all children see how an experience or experiment that is repeated over and over again may have the same results each time. This will lead to deductions that the same result will always be obtained when the experiment is repeated with the same materials, in the same way, and under the same conditions. But when the experiment has been changed or modified the least bit, different results take place.

This above situation brings forth much questioning, searching, more experimenting, and the forming of modified concepts. The why, the when, and the what is then brought into the searching. Learned concepts now begin to mature, to be modified, and to be interpreted within the realm of their learning. Science should then become an exciting and challenging area for them.

All new science concepts should be formed only after the heritage of past science concepts have been examined. These areas of learned facts of the past have a very important purpose of guiding the information of newly formed concepts. In turn the newly formed concepts should be established only after their effects upon the lives of all people have been considered.

In order to develop a good science program in the elementary school, educators of teachers and administrators would do well to go to the source of the problem—the teachers themselves. This has been done by many of our group who are engaged in the training or supervision of teachers. The following four points seem to be the barriers to good science teaching in the elementary schools.

1. How do you get teachers to start a program of science experiences with children of the elementary schools?
2. How can you encourage them to say "I don't know the answer, but we will find out together?"
3. Perhaps a needed "crutch" (teacher-selected area) should be selected to provide the gap between college training and teaching in the field to help build security for the teacher, and rapport with her group.
4. The children should develop an awareness to the many concepts that still need to be learned, as well as those already learned.

Much can be done in the colleges today by the instructors of future teachers. They can encourage the following attitudes when working with children:

1. The teacher in the elementary school should not give answers but rather help the children search for correct answers.
2. There may be many answers which will lead to research in other areas or fields.
3. The children should always be helped by what the teacher knows, never hindered by it. Allow children to find out and do research for themselves.
4. Be aware of the many concepts that still need to be learned, as well as those already learned.
5. There should be exploration of areas of science in which children have had no experience, such as space, spaceships, moon and sputnik.

6. A specific time should be set aside for developing basic skills in science, but a time should also be provided for individual experimenting and for becoming aware of the vast world of science around him to be explored.
7. An environment of freedom and science materials should be set up so that various experiences may be pursued.
8. Don't neglect experiences with the physical aspects of the earth.

It was agreed by all within the group that there is a great need for more depth in the science teaching within the elementary schools. Many more areas should be studied through meaningful experiences and experiments, since children are better able to learn during the early formative years. They do not have as much to unlearn before developing new meaningful concepts as they do later in life. Therefore the study of gravity, relativity, space and atomic energy should be included in the elementary school program. Their interest is keen at this time, and their concept formations more easily attained.

Group 3. Adolescent Development as a Foundation for Science Education.

Discussion Leader:—Robert Gifford, Baltimore County Public Schools, Baltimore, Maryland.
Extension Reporter:—Alfred Beck, Division of Junior High Schools Board of Education of the City of New York.
Discussion Resource People:—Henry F. White.
Reported by:—Peter Dean, Teachers College, Columbia University.

The discussion began with a consideration of the meaning of the term "Adolescent Development." The term "adolescent" was accepted to refer to the individual between the ages of 13 and 17. The term "adolescent development" was explained as referring to the slow, gradual, process of maturing with its manifold aspects of physical, social, intellectual, moral and character development. As individuals pass through this stage they have a large number of needs and interests some of which are known to the individual, others of which the individual at that age does not recognize.

A curriculum developed to meet the needs and interests of adolescents must take into account not only those needs and interests manifested by the student, but also those long term needs of which the teacher may be aware but which the student is not. This includes things as the necessity for proper mathematical skills as a prerequisite for success in the vocations associated with the physical sciences. A grave teaching and guidance problem appears implicit in such a statement of curriculum. The students will learn best that which they are motivated to learn, and things for which they do not feel a need or which they are not interested are not well received.

Because of the above considerations the group felt that in a large measure the present school curriculum is overly preplanned in detail, particularly in view of the multifold futures of children academically, vocationally and socially, and their resultant differing real needs. But not well enough planned for the individual particularly for the brighter students, many of whom are not challenged.

However, it is realized that there does exist a common core of needs, such as: the need for security, the need for affection, the need to know one's body, the need to be an affective citizen of a democracy, and others.

A consideration of those common needs leads to several obvious consequences. It must be understood that an understanding and sympathetic teacher who has worked with children will see in the behavior of children the expression of various needs in varying intensity. When a class begins to work to meet these needs it is very important that the objectives be real in the minds of the students.

An example of the manner in which the needs of adolescents influence the curriculum and the nature of instruction may be seen by examining the influence of the "need for security."

The need for security manifests itself in many ways, the need for economic security, the need for social security, the need to find security in being an individual, the need to be secure about sex, all are part of the greater need.

In planning educational experiences it is important that the planners recognize that schooling is not all of education and that science education is not all of schooling.

The science program must be recognized as a part of a greater whole. Also it must be recognized that a student will be secure if at least one path to approval is known and if each person has a chance to achieve success. The platitude that "nothing succeeds like success" is very true, and of great importance in planning school experience. The relation of the instructional methods to the needs of the students is just as important as the relation of what is taught to the needs of the student. Science is not only facts but also methods and attitudes. The facts can be taught, but they must be taught by methods that are consistent with the methods and attitudes of science.

Teachers tend to do things that are educationally unsound in order to meet the expressed needs of the students. Students want specific direction, they want to know exactly what is expected of them, yet the science teacher is trying to persuade them to be original, independent, and become searchers after new ways of doing things. The effects of such things as College Board Examinations, Regents examinations, assigned projects, science fairs, notebooks, drawings, and evaluation must be examined with these two aspects in mind.

Turning to the practical situation in the schools it seems that it is universal experience to find that there is a loss of interest in science as the student enters adolescence. There seem to be two major causes for this: one is the reorientation toward life that the adolescent is undergoing at this time, which is reflected in changed interests and attitudes, the other is the nature of instruction. Teachers talk too much, tell too much, are not challenging, use too much busy work, stick too close to the course of study, and are too insecure themselves.

Teachers should be "teacher-minded," have positive attitudes towards teaching, be secure, recognize the difference between teaching and the regurgitation of past experience, and understand adolescent psychology.

This situation as regards teachers reflects back upon teacher training and indicates a need for continuous in-service education. The workshop approach seems to offer most promise in this connection. Science teachers in particular must know how to use equipment and perform demonstrations. They should, while they are learning necessary content, learn how to teach this content. In other words the content teacher should take his students behind the scenes.

The whole question of the relation of content to education should be thought out carefully. Such things as the teaching of skills and facts as opposed to teaching how to think and work, need to be examined. The teacher's function should be to awaken interests, develop attitudes and problem solving skills and, in short, to provide learning situations and let the children learn.

Considering the nature of adolescents and the ways in which they learn best and the teachers that are now available the question of homogeneous grouping becomes important. The advantages of homogeneous grouping seem to be: there will be more experiences of success for each group, vocational needs will differ between groups, and experiences can be tailored to fit each group, students will not be singled out as being at such an extreme in a homogeneous group, and will suffer less psychological harm.

On the other side of the ledger are such considerations as these: teachers will fail to challenge slower groups; they will tend to underteach lower groups; and they are not culturally matched to groups largely

representing different social orders and tend to misunderstand the students.

If grouping is decided upon it is important that all groups be allowed to make a contribution to the school and that grouping be for particular areas or purposes rather than general throughout the day.

The basis for successful grouping would seem to be reading level and mathematical ability, at least as far as science is concerned.

The discussion group endorsed homogeneous grouping on the above basis and with the qualification that the items listed on the con side be zealously guarded against.

The discussion group wishes to be recorded as feeling that the conference had great value, and that the provision of an extended length of time was very desirable in as far as a much greater depth could be attained.

It is suggested that grouping in future meetings of this type should be on the basis of age interest, and that the scope of discussion should be more limited.

Group 4. Our Society and Its Needs as a Foundation for Science Education

Discussion Leader:—Charles Prewitt, Willimantic State Teachers College, Willimantic, Connecticut.
Extension Reporter:—Hugh Allen, Montclair State Teachers College, Montclair, New Jersey.
Discussion Resource People:—T. B. Hayre, State Teachers College, Cheyney, Pennsylvania; S. R. Powers, Teachers College, Columbia University.

What are we going to do in our society with current scientific advancements?

Are we threatened in our very existence because of the level of science?

Can we as science teachers, help our children to understand their role in solving social problems?

How do children get values?

Where do ideas come in?

How do teachers get social perspective?

What are the social issues?

Do we need wider planning and more intelligent use of our resources (including human resources)?

Do we have a society in which all are making the maximum contribution?

Are teachers cognizant of social changes? How do they become so?

What is our obligation, as teachers of science, to

1. Underdeveloped countries?
2. The proper use of leisure time?
3. To the proper use of the products of technology?

These are some of the questions which came up for discussion in this group. No attempt was made to answer all of these, but rather to explore the issues involved.

Initially, the concept of our society in its broadest sense was introduced—our world society. The first question to arise in this discussion was "Are we threatened in our very existence because of the level of science?" Cited in example was Burma, a country where there is an abundance of meat and citrus fruits but where mothers lose a large percentage of their newborn because of an inadequate diet consisting mainly of polished rice. The superstitious belief that other foods will cause their children to have undesirable dispositions prevails.

"Can we, as science teachers, help our children to think that they have a role in societal problems?" So often children have not realized that they have a part to play in society's needs. The teacher has a responsibility here.

How do children get values? What is the teacher's responsibility? We must do more than just teach how "gadgets" work. We need to reassess—to ask, "Is this the thing we wish to do with our scientific talent?" Little children use science to their own ends, later it begins to take on a fuller meaning.

What are the social issues? The social issues come from questions—questions such as, "How do I get a job?" If they are not in the questions young people have, then is it a social issue?

In relation to this the following issues were noted.

1. *The gap between science and religion.* While this gap is getting smaller, this area still offers challenge. (For example in relation to "sputnik" and the concept of the universe.) Should not religion and science reinforce each other?

2. *Values—and putting things in their proper relationships.* Many people and groups of people in our society are biased and fail to see things in their proper relationship. What is the science teacher's responsibility here? Advertising may be responsible for causing people to want and to buy things they really don't need. Further if we manufacture 400 h.p. automobiles which will exceed posted speed limits and cause people to want them, do we as science teachers have an obligation here?

4. *Intelligent use of our resources.* Are all in our society making their maximum contribution thereto? We have approximately 75,000 more mouths to be fed in the world each morning and with this the question takes on significance.

5. *More simplified terms.* The search is on for more adequate vehicles than words to express things. The science teacher must constantly be searching for this.

6. *Up-dating teachers.* The problem of changing concepts and the rapid expansion present a real challenge to the teacher of science. How can we know that what we are teaching is up to date?

"Our Society and Its Needs" seems to be a personification—but perhaps appropriately so since our society is composed of individuals. We have a responsibility in keeping our society a "good place to live." The "voice of society" is calling for a better understanding of the nature of things. Everyone wants to know how things go on in life. This offers a real challenge to the teacher of science. The question "What do we do in teacher education to make the teacher conscious of the needs of society?" came up repeatedly during this session. Do we in teacher education have programs which cause teachers to recognize the community, the changes occurring in the community, the raw materials used, the labor needed, the products effected, and so on? If we take ourselves seriously with respect to the needs of society, should not we make provision in teacher education? Teachers must see that it is important to recognize societal change. Teachers colleges need to make more provision for the exploration of interests in their programs.

There were some suggestions as to how this might be accomplished. One suggestion was a more realistic arrangement with science students working alongside research professors in colleges and universities, and in utility and industrial laboratories. Another suggestion was for a more realistic problem-solving approach in our college classes—whereby the student might select his area of interest and, with proper staff direction, carry through to an appropriate solution.

We were reminded that there are two kinds of needs—those which give intellectual challenge, and those practical (sometimes unidentified) needs. For some these are the same; for others this may not be true. The question arose as to whether or not our school environment is not becoming a little "dilute" presently as compared to that of other nations. Perhaps we need more stress on those needs which give intellectual challenge presently and see what can be done to regain any scientific leadership which we might have lost recently.

It Is Important That The Science Educator Work To Get The Rightful Place For Science In Our Society—A More Realistic Program.

ASSOCIATION FOR THE EDUCATION OF TEACHERS IN SCIENCE

New Jersey State Teachers College, Trenton, New Jersey

SPRING MEETING

May 3–4, 1957

Program chairman for Spring Meeting: Victor Crowell, New Jersey State Teachers College, Trenton, New Jersey

Officers

President: Robert Wickware, Willimantic State Teachers College, Willimantic, Connecticut
President-elect: June Lewis, New York State Teachers College, Plattsburgh, New York.
Vice-President, East: George Zimmer, New York State Teachers College, Fredonia, New York.
Secretary-Treasurer: Willard Jacobson, Teachers College, Columbia University, New York, New York.

Executive Committee

F. L. Fitzpatrick, Teachers College, Columbia University, Frank X. Sutman, New Jersey State Teachers College, Paterson, New Jersey, John Wells, Madison College, Harrisonburg, Virginia

Friday, May 3

9:30–10:00 Registration and Greetings—Lounge of Centennial Hall.

10:00–11:20 "Testing for Growth in the Element of Scientific Thinking." Preview of new STEP tests. Fred Ferris, Head of Science Section, Educational Testing Service.

11:30–12:30 Group Discussion of Problem of Testing. Report of Committee on High School Physics. Tests for A.A.P.T.—AIP—S.S.T.A. Fred Pregger, Assistant Professor of Science, State Teachers College, Trenton, New Jersey.

12:45–1:45 Lunch—Phelps Hall, Rooms A, B, C, D. $1.00—Advance Reservations Requested.

2:00–5:00 "Recent Developments in Electronics." Tour of Research Laboratories of Radio Corporation of America, Princeton, New Jersey.

6:00–8:00 Dinner—Phelps Hall, Rooms A, B, C, D. $1.50—Advance Reservations Requested. Herbert Schwartz, Professor of Education, State University Teachers College, New Paltz. "Functional Education in an Island Situation."

Saturday, May 4

8:15–9:00 Breakfast—Phelps Hall, Rooms B, C. $.75—Advance Registration Requested.

9:00–10:15 Lounge—Centennial Hall. "Criteria for Selecting Content for a Methods Course In Science Education." Irvin H. Gawley, Assistant Professor of Science; State Teachers College, Montclair, New Jersey; Frank X. Sutman, Assistant Professor of Science; State Teachers College, Patterson, New Jersey.

10:20–11:45 Presentation of Two Programs for the Education of Teachers of Science and Evaluations and Criticism of the Programs by Conference Members.

(a) "The Program at Montclair State Teachers College," Rufus D. Reed.
(b) "The Program at Trenton State Teachers College," S. M. Troxel.

11:50–12:30 Summary of Conference and Business Meeting.

12:45–1:45 Luncheon—Rooms A, B, C, D. Phelps Hall. $1.00—Advance Registration Requested.

1:45 Adjournment.

SCIENCE FOR SIX-YEAR-OLDS

Mildred Ballou

Chairman, Primary Science Curriculum Committee, Des Moines Public Schools, Des Moines, Iowa

"What kind of a leaf is this?"

"What is that fuzzy, crawly thing?"

"How does the water get up in the sky so it can rain down on us?"

These questions, and hundreds more, are indicative of the delightful curiosity of the six-year-old! His world had broadened from home and family to include a vast out-of-doors. At six a child usually resolves the myth of Santa Claus and the Easter Bunny. He is beginning to become skeptical about make-believe, but all too often he goes on thinking thunder is angels moving their beds around, and that it rains when God turns on the faucet. As teachers our privilege is to provide a science program which encourages the child to experiment, to explore, and to discover ways to find answers to his problems.

A good science program for six-year-olds

is based on child growth and development. The program must be both incidental and planned. The teacher need not be a scientist per se, but she must be willing to learn science with the children.

CHARACTERISTICS OF A SIX-YEAR-OLD

Six-year-olds are adventurous, curious, and demanding. 'Six-year-oldness,' because it follows angelic 'five-year-oldness,' is often distressing to both parents and teachers. The mother, who knew so well the angelic five-year-old, is likely to say when he turns six, "He's a changed child. I don't know what's gotten into him."

To understand the tremendous change the six-year-old is undergoing a picture of the behavior patterns of five-year-olds is requisite. Dr. Arnold Gesell in his book *The Child from Five to Ten* describes five as a golden age. The five-year-old is docile, anxious to conform, contented. He does not distinguish readily between fantasy and reality. He is an ardent believer in magic. He is not in a pioneering phase of development. His world is confined to the here-and-now: mother, father, home and the immediate neighborhood. He is very innocent in the realm of causal and logical relationships. He is willing to accept that clouds move because God pushes them, and when God blows it is windy.

Six is an age of transition. A six-year-old is not a bigger and better five-year-old. At age six the child is becoming an active, aggressive, inquisitive human organism. He is high-spirited. He literally dances with joy when happy and wails and shakes with grief when unhappy. He is intrigued by the multifarious world around him and takes every opportunity to explore and investigate it. As he searches for the 'true' and the 'real,' he touches, handles, smells, tastes, and tests objects that interest him. He is uninhibited, asks numerous questions, and is quick to admit he does not understand. The characteristics of the six-year-old mentioned seem to indicate the child is a poor subject for regimentation in his school program.

THE SCIENCE PROGRAM

Teachers of six-year-olds must be cognizant of children's characteristics and provide a science program in which the children have an opportunity to investigate the important objects around them by doing, tasting, trying, touching, and feeling. They are usually not satisfied merely to be told about something. They want and need to discover WHY, WHEN, and HOW. What, then, can a teacher do to capitalize on this insatiable curiosity and provide a science program which directs this boundless energy into channels of learning?

A good science program for six-year-olds must be both incidental and planned. An incidental program in science is necessary because at this age the child is busy investigating his world and collecting items to share with his classmates. He is likely to bring to the classroom leaves, insects, stones, twigs, teeth, worms, weeds, seeds and numerous other specimens from his environment. He wants to know what they are and all about them. The teacher must realize that it is important to help the child identify his treasure. Often she will not know what kind of a leaf he has brought, but together they can find a book or resource person to help solve the problem. Specimens brought in by six-year-olds must be dealt with as soon as possible. The teacher who says, "We'll look at your leaves tomorrow," or merely lets the child show his leaves and then asks him to deposit them in the waste basket discourages him. She fails to capitalize on the delightful curiosity of the six-year-old. In the classroom where the teacher has evidenced a high respect for specimens brought in by the children innumerable interesting things are certain to appear. Her problem, then, is not one of building interest, but rather of keeping up with the ever growing interests of her pupils.

An adequate science program cannot be totally incidental. A planned program in science is necessary for making sure no area of science is neglected. For example, the children in the classroom to which a

cocoon is never brought have a right to know about the metamorphosis of an insect, just as do the children in the classroom to which a cocoon is brought. The planned science program should provide for the development of major understandings in each of these areas: animals, plants, rocks and soil, weather, simple machines, sun, moon, and stars, and foods and health. How much children learn about each area will depend upon their interests and abilities. The program must be flexible. A rigid curriculum which designates the study of weather, for example, as strictly a second grade subject which the first grade dare not mention is not advisable. As pupils mature through the grades additional learnings on each subject should be possible. All there is to know about weather cannot be learned in a single year! Perhaps that is the reason why most writers of modern science texts include something in each of the areas mentioned for each grade level.

A List of Suggested Activities Which Can Be Planned as a Part of a Science Program for Six-Year-Olds

Animals

1. Take a field trip to observe animals at work.
2. Have a pair of rabbits in the room. Children may be able to watch young rabbits being born.

Plants

1. Identify neighborhood plants, to learn their names.
2. Plant a garden to see how plants grow.

Rocks

1. Collect rock specimens from the neighborhood. Learn to identify them.
2. Make soil in class to understand the composition.
3. Let the water from a faucet drip on a piece of limestone to show erosion.
4. Find samples of different layers of soil and put them in correct order in a clear glass bottle.

Weather

1. Make simple weather instruments such as weather vanes and rain gauges to learn about weather.
2. Bring snow into the room and let it melt to determine ratio of snow to water.
3. Make a calendar to use to record sky condition, precipitation, and temperature for a period of time.
4. Make paper dolls and a set of clothing for them so children can select proper clothing for certain temperatures and weather conditions.

Sun, Moon, Stars

1. Make pictures that show how we use sunlight.
2. Visit an observatory to learn about the heavens.

Simple Machines

1. Bring household machines to school to learn whether they are or are not simple machines.
2. Make a pulley from a spool or the pencil sharpener to learn how it works.
3. Compare the ease of moving the block box with and without a set of wheels.

Foods and Health

1. Do a foods experiment with two hamsters, feeding one good foods, the other poor foods to see the effect the foods have on the hamsters.
2. Prepare two large pans of congealed unflavored gelatin. Press pair of washed hands on one, soiled hands on other. Watch germs grow on one, not the other.

A good science program enhances the total school program for six-year-olds. The development of science experience charts written by teacher and pupils will lend impetus to the reading and language programs. The desire to be able to get science information from books makes learning to read a must. Expressing findings in science before a group provides oral language experience. Counting specimens and using the thermometer contribute significantly to number concepts. Understanding how discoveries in science affect people contributes to learning in the social studies area. Recording his concept of a rainy day can be done at the painting easel. Singing about "Mr. Mosquito" is entered into with gusto even by the boy who dislikes music.

The teacher who provides a good science program for six-year-olds need not be a scientist per se. She does need to know the characteristics of six-year-olds and be willing to learn science with them. Teachers need to remember that the six-year-old is quick to sense her willingness to help him learn about the 'real' and the 'true.' The teacher who would meet the needs of her children can do no less!

JOE ZAFFORONI

The last president of the National Council for Elementary Science was Joe Zafforoni who served as its president during 1957–1958. The N.C.E.S. has now officially changed its name to The Council of Elementary Science International. Mr. Zafforoni follows a long line of outstanding Presidents of the N.C.E.S. and during his term of office has served the organization with excellent leadership.

Mr. Zafforoni was born in Cle Elum, Washington, June 14, 1920. He has a B.A. degree from Central Washington College of Education, Ellensburg, Washington, 1941 and an M.A. degree from Colorado State College, Greeley, Colorado, 1947. He has completed his residence work and course requirements at Teachers College, Columbia University for his doctoral degree. Data has been collected for his thesis and is in process of being written up. Military service included three years in the Corps of Engineers, 1942–45. He saw duty in Great Britain, New Guinea, the Philippines, and Japan.

Teaching experience includes: Elementary Teacher and Vice-Principal, Ellensburg, Washington, Public Schools, 1941–42; 45–46; Supervisor of Sixth Grade, Ernest Horn Elementary School, Colorado State College, Greeley, Colorado, 1947–48; Assistant professor of science education, Eastern Washington College of Education, Cheney, Washington, 1948–53; Laboratory assistant in elementary science, Teachers College, Columbia University, 1953–54; Assistant professor of Elementary Education, University of Nebraska, Lincoln, Nebraska, 1954 to present time. Summer session and post-summer session teaching includes Johns Hopkins University 1956; University of Toledo, 1956; Butler University, 1957; University of Arizona, science workshop, 1958; Battle Creek, Michigan, science workshop at camp, 1958.

Mr. Zafforoni is a member of N.C.E.S., A.S.C.D., N.E.A., N.S.T.A., and A.C.E.I. During his year at Teachers College he held a Fellowship in Natural Science. During 1956–57 he was Vice-President of the National Council for Elementary Science and is now a member of the Board of Directors of The Council of Elementary Science International.

Publications are found in the *Washington State Journal* and the *Elementary Science Bulletin of N.S.T.A.* Mr. Zafforoni has been appointed recently to the American Library Association Editorial Committee as Consultant in elementary science for the *Basic Book Collection for Elementary Grades.*

Mr. Zafforoni has a son Craig L., age seven. Present activities and hobbies include; elementary science workshops, writing a thesis, tropical fish, and gardening.

Clarence M. Pruitt

PROGRAM NATIONAL COUNCIL FOR ELEMENTARY SCIENCE

In Collaboration with Association for Supervision and Curriculum Development

OLYMPIC HOTEL, SEATTLE, WASHINGTON

March 1–2, 1958

Elementary Science for a Changing World

March 1, 1958

9:00–9:30 Registration

9:30–11:30 General Session Olympic Bowl

Presiding: Joe Zafforoni, University of Nebraska, President, National Council for Elementary Science

Welcome: E. W. Campbell, Superintendent of Schools, Seattle Public Schools, Seattle, Washington

Address: "Elementary Science for a Changing World," John Navarra, Associate Professor of Science, East Carolina College, Greenville, North Carolina

Discussion of theme: Elementary science for a Changing World

Discussants:

Ruth Roche, Assistant Professor of Elementary Education, Los Angeles State College, Northridge, California

John D. McLain, Supervisor of Elementary Education, South Milwaukee Public Schools, South Milwaukee, Wisconsin

Arnold M. Lahti, Assistant Professor of Physical Science, Western Washington College of Education, Bellingham, Washington

E. Bernice Owens, Assistant Professor of Education, The School of Education, North Texas State College, Denton, Texas

Discussion from the floor

12:00–1:45 Luncheon Grand Ball Room

Presiding: Gerald S. Craig, Professor Emeritus of Natural Sciences, Teachers College, Columbia University, New York

Address: "Educational Television and Elementary Science," Dixie Lee Ray, Professor of Science, University of Washington, Seattle, Washington

2:00–3:45 Group Discussions

Discussion Group I. Queens Room

Discussion Leader: Fred Knapman, Professor of Physical Science, Western Washington College of Education, Bellingham, Washington

Resource Persons: Ruth Roche, Los Angeles State College, Berne Biteman, Van Asselt Elementary School, Seattle; Dave Rushong, Sedro Woolley Junior High School, Sedro Woolley, Washington; William Wilder, Principal, Sunnyland Elementary School, Bellingham, Washington

Recorder: Mary Lou Morrow, Rosehill Elementary School, Mukilteo, Washington

Discussion Group II. Empire Room

Discussion Leader: Albert Piltz, Consultant, Elementary Education, Science, County of Los Angeles, Los Angeles, Calif.

Resource Persons: John McLain, South Milwaukee Public Schools; Dale Buckley, Principal, Green Lake Elementary School, Seattle, Washington; Jerry Flora, Assistant Professor of Biological Science, Western Washington College of Education, Bellingham, Washington; Robert Peach, Ferndale Junior High School, Ferndale, Washington

Recorder: Janice Nelson, Sherman Grade School, Tacoma, Washington

Discussion Group III. Pacific Room

Discussion Leader: Lyn E. Brown, Jr., Philadelphia, Pennsylvania

Resource Persons: Arnold Lahti, Western Washington College of Education; Dorothy Baker, Curriculum Consultant, Everett, Washington; Donald G. Olts, Principal, John Muir Elementary School, Seattle, Washington; Ed Ringen, Cascade Elementary School, Marysville, Washington

Recorder: Jesse How, Ravenna Elementary School, Seattle, Washington

Discussion Group IV: Evergreen Room

Discussion Leader: Laurie Mae Carter, Meridian Public Schools, Meridian, Mississippi

Resource Persons: E. Bernice Owens, North Texas State College; Lee Rhodes, Edmonds Junior High School, Edmonds, Washington; Frances Shelton, Crown Hill Elementary School, Seattle, Washington; Allan Thon, Principal, Silver Beach Elementary School, Bellingham, Washington

4:00–5:00 General Meeting Olympic Bowl

Discussion of theme by discussants and major speaker.

Discussion from the floor.

Evening: Informal discussion for council members and friends

March 2, 1958

9:30 Annual business meeting of the National Council for Elementary Science. Fourth Avenue Room

ACTIVITIES OF THE NATIONAL COUNCIL FOR ELEMENTARY SCIENCE

February 22—Meeting in Chicago, Illinois in conjunction with the National Association for Research in Science Teaching

March 1 and 2—Meeting in Seattle, Washington in conjunction with the Association for Supervision and Curriculum Development

April 11 and 12—Meeting in Atlantic City, New Jersey in conjunction with the Association for Childhood Education International

OFFICERS OF THE NATIONAL COUNCIL FOR ELEMENTARY SCIENCE—1957–1958

President: Mr. Joe Zafforoni, Assistant Professor of Education, University of Nebraska, Lincoln, Nebraska

Vice-Pres.: Dr. June Lewis, Professor of Education, State Teachers College, Plattsburgh, New York

Vice-Pres.: Dr. Willard Jacobson, Associate Professor of Natural Sciences, Teachers College, Columbia University, New York 27, New York

Sec.-Treas.: Dr. Julian Greenlee, Professor of Education, State University, Tallahassee, Florida

Board of Directors: Dr. G. Marian Young, Professor of Education, University of Florida, Gainesville, Florida; Dr. Al Piltz, Board of Education, Los Angeles, California; Miss Bonnie Howard, Board of Education, Louisville 2, Kentucky; Mrs. Muriel Beuschlein, Science Department, Chicago Teachers College, Chicago 21, Illinois; Dr. Rose Lammel, Professor of Education, New York University, Washington Square, New York; Dr. Gerald S. Craig, Professor Emeritus of Natural Sciences, Teachers College, Columbia University, New York 27, New York

MINUTES FOR THE NATIONAL COUNCIL FOR ELEMENTARY SCIENCE

ANNUAL BUSINESS MEETING—MARCH 2, 1958

THE annual business meeting of the National Council for Elementary Science was held in the Fourth Avenue Room, Olympic Hotel, Seattle, Washington, Sunday morning, March 2, 1958 with Mr. Joe Zafforoni presiding. There were twelve members present.

Those in attendance were: Lynn Brown Jr., John McLain, Arnold Lahti, Willard Jacobson, John Navarra, John Schrader, Mervin Johnson, E. Bernice Owens, Louisa Pike Crook, William F. Murray, E. F. Austin, and Joe Zafforoni.

Mimeographed copies of the minutes of the last meeting were distributed to the members since Julian Greenlee, our secretary was unable to attend the meeting. They were approved as read. Several members present indicated that they had not received the Elementary School Science Bulletin. It was suggested that one of the causes was the inaccuracy of many of the current addresses. Members need to feel they are getting as much current information as they can from the organization. It was also suggested that there might be more continuity of membership if the Bulletin was received regularly by all members. Lynn Brown offered to keep the membership list and suggested a double postcard arrangement to keep in contact with members.

Willard Jacobson brought up the possibility of changing the name of the National Council for Elementary Science. This had been previously indicated by Dr. Craig in the general meeting. Some of the possibilities that were discussed were: Council for Elementary Science International; International Council for Elementary Science; and Council for Elementary Science with a sub title of (International). It was felt that the word National in the present title tended to exclude educators from Hawaii, Alaska, Canada, and foreign countries who might become members of the organization. Other discussion indicated a need to examine the purposes of the organization if it is to continue as the National Council for Elementary Science.

Willard Jacobson made a motion to change the title of the National Council for Elementary Science to The Council of Ele-

mentary Science International. The motion was seconded by John Navarra and carried by a unanimous ballot.

Joe Zafforoni suggested that Mrs. Muriel Beuschlein should be credited with fine leadership in the planning of the program for the recent meeting with N.A.R.S.T.

Several items were discussed relative to the distribution of materials to classroom teachers. One suggestion was to use the bulletin for advertisement in getting information. The advisability and cost of distributing the N.S.T.A. packet of science materials was discussed. Joe Zafforoni indicated a need for more news items for the Bulletin. However, it was indicated that the C.E.S.I. isn't a distribution agency.

The following motion was made by E. Bernice Owens in conjunction with the preceding discussion:

The motion was made that the president of C.E.S.I., Joe Zafforoni, select a committee to study ways to further promote the purposes of this organization, to submit a plan for doing this to the officers of this organization for refinement, and if this seems advisable, investigate ways of securing money for implementing the plan such as: The President of C.E.S.I. submit the final plan to the National Science Foundation, asking for a grant.

The motion was seconded and carried.

Willard Jacobson was selected chairman of this committee and given authority by president Joe Zafforoni to select two other members for the committee.

E. Bernice Owens, of the Nominating Committee, submitted the following slate of officers for the coming year.

President: June Lewis, University State Teachers College, Plattsburgh, New York

First Vice-President: Willard Jacobson, Teachers College Columbia University, New York City, New York

Second Vice-President: John Navarra, East Carolina College Greenville, North Carolina

Secretary-Treasurer: John McLain, South Milwaukee Public Schools, South Milwaukee, Wisconsin

Board of Directors: Joe Zafforoni, University of Nebraska Lincoln, Nebraska; Ruth Roche, Los Angeles State College Los Angeles, California

E. Bernice Owens made a motion that the nomination committee report be accepted as read. The motion was seconded and carried by a unanimous vote.

Willard Jacobson made a motion that the C.E.S.I. meet with N.A.R.S.T. in Atlantic City next year and that we ask the speakers submitting papers to provide reprints for our C.E.S.I. members. The motion was seconded and carried.

A motion was made by John Navarra that the President appoint a program chairman for the N.A.R.S.T. meeting in Atlantic City. The motion was seconded and carried.

Arnold Lahti, Western Washington College, Bellingham, Washington, was appointed by President Joe Zafforoni.

The members present expressed appreciation to Willard Jacobson, program chairman, Arnold Lahti and Louisa Crook, local chairman for their fine work in preparing the program and insuring the success of the Seattle meeting.

Lynn Brown made a motion that we continue to send a C.E.S.I. representative to the National Safety Council and continue our cooperation with them. The motion was seconded and carried.

John Navarra made a motion that we explore the possibility of having meetings in conjunction with chapters of the A.C.E.I. outside the Continental United States with Canada, Alaska, Hawaii, and Puerto Rico our most immediate concern. The motion was seconded and carried. John Navarra was selected to take this responsibility at the request of President Joe Zafforoni.

There being no further business, the meeting was adjourned.

Respectfully submitted,

Mervin L. Johnson
Secretary pro-tem

PANEL NOTES

Discussion Group I. "Elementary Science for a Changing World"

The ideas which were expressed in this discussion group are included under the following general topics: (1) What you should look for in a science teacher; (2) pre-service and in-service training for teachers; and (3) curriculum implications.

What you should look for in a science teacher

The following general conclusions were expressed:

A teacher who possesses the ability to inspire her pupils and make science interesting and fascinating.

The teacher who possesses intellectual curiosity and is able to stimulate curiosity in her children.

A teacher who has a broad background in science.

A teacher who is open-minded and alert to creative ability in children.

A teacher who does not inhibit youngsters and is willing to learn along with them.

Of importance is the teacher who is able to discriminate values and select vehicles in technic or skill most suited to the characteristics of the child.

Preservice and inservice training

It was recognized that the minimum requirement in science units in many institutions of higher learning for graduates should be raised, if self-contained classrooms are to continue.

A large number expressed a need for inservice training program. The following procedures were followed in some schools cited:

Qualified science teachers, those having prior experience and background training in science, were used to assist principals in training other teachers.

In other situations, the aid of talented high school students were enlisted to give demonstrations, perform experiments or assist the teacher with little science knowledge in the use of a science kit.

One community promoted a "Helping Teacher Program" for all new teachers. (one competent teacher works with each new teacher for the first half of each year.)

To inspire and encourage self-improvement, ideas were expressed to allow time off from classroom for training.

Several present believed that fellowships for elementary science teachers should be encouraged.

Some teachers expressed the need to learn more content courses for a broader and fuller understanding of subject matter, particularly in mathematics, zoology, and physical sciences.

It was concluded that more and more school administrators were assuming obligation for in-service programs to meet the needs of their teachers, through teacher conducted curriculum study, supplemented by workshops, and consultant service.

Curriculum implications

Considerable discussion revolved around structured or non-structured curriculum. The following convictions to support the structured curriculum were offered by a few teachers:

Teachers tend to teach little or no science when they are incompetent or only in areas where most competent.

That teachers may not recognize all learning situations or inhibit youngsters without the guide of a structured curriculum.

Teachers may teach along special interest to them, while neglecting to teach the fundamental science principles.

An appreciable number commented in favor of joint teacher and child planned units over a fixed structured curriculum.

The following arguments were presented:

Timely units are more adaptable for purposeful learning.

Formal learning, after personal experience, becomes more meaningful.

It is necessary to have contacts with realities beyond the class-room which may involve actual participation and manipulation of materials. Principles learned can be adapted to any grade level.

A point was made that learning was constant—children never cease learning.

An observation was made that a poor science teacher may do more harm by attempting to teach a structured curriculum than by teaching no science.

Instances were shown where science programs were enriched by using community resources, such as field trips, speakers from industries, community improvement, and others. Card files were set up on available out-of-school resources.

MARY LOU MORROW
Recorder, Rosehill Elementary School
Mukilteo, Washington

DISCUSSION GROUP II REPORT

1. Public establishes policy of the schools.
   A. As educators, how are we to educate the public?
      1. We must not give way to pressure groups.
         a. Public wants more science and math, but we can't go overboard for science.
         b. Other subjects will be neglected.
   B. We should not forget the purposes of American education.
   C. We should reevaluate the child development concepts.
   D. We need to take a good honest look at ourselves.
      1. In regard to science and mathematics.

II. What can we do to let the public know what we are doing?
   A. Radio and T.V. Programs.
   B. Newspaper publicity.
      1. Glencoe P.T.A. do public relations with a column in the paper once a week, often having pictures.
   C. Principal invites the public to school.
   D. Community Conferences.
   E. Best public relations is done by the children in the class.

III. What are the methods of improving Science teaching?
   A. In service workshops when teachers ask for them.
   B. Good and adequate materials.
   C. Determining the scope and sequence of science in the elementary school.
      1. What is the description of science?
         a. The world we live in.
         b. Problem solving.
   D. Develop the questioning attitude in children.
      1. Talk content to them whenever possible.

JANICE NELSON
Recorder, Sherman Grade School
Tacoma, Washington

DISCUSSION GROUP IV REPORT

The leader brought the meeting into motion by the suggestion that each of the resource persons point out some of the science activities, (or approaches for advancing science learnings) that had been used in his particular region and, also, to suggest any questions that might be put before the group for exploration.

Frances Shelton named several techniques that are being used in the Seattle schools:

1. Workshop for teachers new to the system.
2. In-service workshops in Science held within regional areas of city.
3. Television teaching.
4. Summer workshops.
5. Science Fairs.
6. A new type of summer school will be started with the summer of 1958 which will be for the faster learners. This will be in addition to the regular remedial type summer school.

Question: In relation to the science program the following questions keep coming up—how much time to be allotted—: What personnel to be used—What kinds of future plans can be made for the use of television, through the use of the resource person and the classroom teacher working as a team?

Allen Thon stated that if we agree on the assumption that the classroom teacher is the key person to effective science teaching, then we need to know how classroom teachers are attacking the problem of obtaining resource people, resource material and instigating and using types of in-service studies.

Lee Rhodes explained that the Edmonds district has been faced with a large growth in population in a matter of a very short time—a growth from around 3,000 persons to somewhere probably in excess of 10,000. This growth brought with it an increase in teaching staff and the problem of co-ordinating curriculum. A group of science teachers decided to work on a curriculum guide that is to be used as a guide rather than as a fast rule of content material. The committee consists of about 30 persons representing all of the high school and all of the junior high school science teachers and as many of the elementary school teachers as indicated an interest. Their point of departure was the 8 basic sciences and identifying materials needed at all levels. They used two approaches, one for the general source materials and the other for an enrichment program. They gathered data from researchers, psychologists, and other agencies that were able to give information concerning children. As they were able to pool their information they changed topics to various spots on the grade range, sometimes up and sometimes down. This study is still in the making.

Dr. Bernice Owens clarified Dr. Navarra's statement that was in the address of the morning meeting. This was the one relating to his belief relative to science learnings as they relate to the stages of child growth and development. She pointed out three items that teachers need to keep in mind as they evaluate their work with children:

Where are the children now?

What do we know now?

Where do we want to go?

She stressed the importance of guidance and that we should be ever alert so that we will not overlook the child's habit of wanting to know. Perhaps we are worrying about too many *things* without realizing that guidance may be the important facet.

The leader pointed out the need to meet the challenge of the present time in a calm, studied manner in order to determine what the science curriculum in the elementary school should encompass. It is a question for many to decide whether it is a part of the total program or whether it is a thing set aside. Should certain requirements be set by a course of study or should the teacher be allowed a freedom of choice.

Rose Arkley of Mercer Island Washington reported that in her school the scope of the teaching of science was the teacher's choice.

Afton Nance of the California Bureau of Elementary Education stated that the teaching of science is not mandatory by state law but is included in the school studies program which is in a time block allotment of about one and a half hours daily. At all times there is a science center in the classroom but it is not required to be in connection with the social studies unit. He reported on a summer workshop (1957) that was held in conjunction with the San Jose State College. The planned curriculum beginning with the kindergarten is permissive and gives a wide range of ideas. The teachers can draw from this source of materials and while they do not teach with the idea of concepts as the main point to be considered, they do hope and expect that the science concepts will be a natural outcome.

Mary Riggs of Honolulu stated that the Territorial Director of Education is of

great influence in the area of curriculum. The person holding this position tends to inspire teachers to put emphasis on the major area in which he studied during his tenure in office. However she hastened to affirm that this did not preclude a well rounded program. Their curriculum was referred to as a "Pie" with the blocks of time designated for curriculum fields. There may not be a uniformity within the blocks of time. The schools have a central materials bank.

R. S. Austin of Tyler Texas expressed concern over the anxieties brought about by outside pressures and the tendency to "run from corner to corner" in an attempt to satisfy the critics. He felt we need to put a lot of things together and decide *how much* and *what* we want children to learn. Are we admitting the science program adequate or inadequate?

Albot Haugerud Seattle, suggested that there was a real need for Colleges, High Schools and Junior High Schools to work together to understand the *why* of teaching science at various levels. His plea was for understanding.

Vivien Haynes, Oklahoma City stressed a need for more "open end" studies and for less of the tight compartments at all levels of the curriculum.

Pearl McDermid, Renton, Washington wished for ways to give the teacher guidance in helping the child whose knowledge is far beyond that of his class. It is a problem with the heavy class loads and the limitations of space and equipment to really help all of the children.

Willard Jacobson remarked that teachers of the elementary schools will come in contact with many interests as they strive to become interested and competent in one area of work. He said that New York state had just made it mandatory to teach science.

Rose Bullie of Reno, Nevada, said that as her region evaluated their communities they found a wide range in practice from a very detailed program to a haphazard program. The result seemed to fit around the kind of program that the community wanted. There were those who felt they must have a content framework in contrast to the other extreme that had no emphasis or concern for outcomes. No doubt somewhere between lies a workable plan.

The discussion seemed to concur along the following lines:

1. To evaluate programs and to check work in other communities so as to avoid duplicate work and to make committees more productive.
2. Perhaps there is some need for agreement in surveys to meet needs of children moving from place to place.
3. Knowledge in science is doubling every 10 years. We need to look to the logic of the subject and to assess it in its place in the total picture of the child's education. We need to continually reexamine in terms of what our society demands of us.
4. Ideally the classroom of the elementary school should have about 20 pupils with a well-trained, interested teacher. There should be a balance of training in the spacial fields within each staff.
5. There is some evidence that from the present day pressures there may emerge trends toward a study-skill type of study with a scope and sequence guide.
6. If we can surmount the psychological block and move toward an integrated program with balance and a use of sound techniques we can meet the needs of the children and the community.
7. Teachers need the "sparkle that children already have."

Bernice Lee
Recorder, Fairview Elementary School
Seattle, Washington

PROGRAM OF NATIONAL COUNCIL FOR ELEMENTARY SCIENCE

In Collaboration with the Association for Childhood Education, International

AMBASSADOR HOTEL, ATLANTIC CITY, NEW JERSEY

April 11–12, 1958

Theme: Evaluating Children's Experiences in Science

Hosts: Local Planning Committee. Chairman: Mr. Charles Sage, Central Junior High School, Atlantic City, New Jersey; Mr. George Dickerson, New Jersey Avenue School, Atlantic City, New Jersey; Miss Gertrude Krepper, Richmond Avenue School, Atlantic City, New Jersey; Mr. Charles Hill, Central Junior High School, Atlantic City, New Jersey; Mrs. Raymond Smith, Central Junior High School, Atlantic City, New Jersey

Friday, April 11, 1958

12:00 Noon–2:00 P.M. Registration in Foyer

2:00 P.M.–5:00 P.M. Field Trip. Tour to see wild bird life, conducted by William Bennett Wright, Conservation Specialist. (Inquire at Registration Table)

6:30 P.M.–7:30 P.M. Room 118. Work-Discussion Group Leaders and Consultants meet with Chairman, Mr. Joe Zafforoni, University of Nebraska, Lincoln, Nebraska

7:00 P.M.–10:00 P.M. Renaissance Room. Panel Discussion Group meet with Dr. Ralph Preston University of Pennsylvania, Philadelphia, Pennsylvania

7:00 P.M.–10:00 P.M. Renaissance Room. Registration and Meeting

Presiding: Dr. Willard Jacobson, Teachers College, Columbia University, New York, New York

7:30 P.M.–9:00 P.M. Panel Discussion:

Topic: The Preparation Teachers Need for Providing Valuable Science Experiences for Children

Moderator: Dr. Ralph Preston, University of Pennsylvania, Philadelphia, Pennsylvania

Panel Members: Dr. J. Darrell Barnard, School of Education, New York University; Dr. Paul Blackwood, Specialist, in Elementary Education, U. S. Office of Education, Washington, D. C.; Mrs. Jessie Wall, University of Connecticut, Storrs, Connecticut; Dr. Marian Young, University of Florida Gainesville, Florida; Mr. Joe Zafforoni, University of Nebraska, Lincoln, Nebraska

9:00 P.M.–10:00 P.M. Demonstration: Using Experiments to Help Children Find Out. Dr. Herbert Schwartz, State University Teachers College, New Paltz, New York

Saturday, April 12, 1958

Presiding: Dr. June E. Lewis, NCES Conference Chairman, State University Teachers College, Plattsburgh, New York

8:00 A.M.–9:00 A.M. Renaissance Room. Registration

9:00 A.M.–10:15 A.M. Welcome and Greetings, Local Chairman, President of NCES

Address: Evaluating Children's Experiences in Science, Dr. Glenn O. Blough, University of Maryland, College Park, Maryland

10:15 A.M.–10:30 A.M. Coffee Break

10:35 A.M.–12:10 P.M. Work Discussion Meetings, General Discussions on Evaluation of Children's Experience in Science

Group I

Renaissance Room

Leader: Dr. Genevieve Bowen, Bureau of Curriculum Development, Harrisburg, Pennsylvania

Consultants: Dr. Glenn O. Blough, College of Education, University of Maryland, College Park, Maryland; Mrs. Helen D. Ross, Lowell Public School, Philadelphia, Pennsylvania

Group II

Surf Room

Leader: Dr. Katherine E. Hill, New York University, New York, N. Y.

Consultant: Mr. Howard L. Conrad, Director of Elementary Curriculum, Board of Education, Philadelphia, Pa.

Discussions on the Evaluation of Science Experiences Related to the Areas Specified

Group III—Atomic Energy

Venetian Room

Leader: Dr. Madge Stanford, Southern Methodist University, Dallas, Texas

Consultant: Dr. J. Darrell Barnard, School of Education, New York University, New York, New York

Group IV—The Earth Satellite and Space Travel

Room 118

Leader: Miss Marian Betar, Public Schools, South Glens Falls, New York

Consultant: Dr. Paul Blackwood, Specialist in Elementary Education, U. S. Office of Education, Washington, D. C.

Group V—Living Things

22 Club

Leader: Mrs. Jessie Wall, University of Connecticut, Storrs, Connecticut

Consultant: Mrs. Alita Westcott, Public Schools, Portland, Maine

Group IV—Conservation

Room 110

Leader: Miss Betty Hone, The Conservation, Foundation Research Education, New York, New York

Consultant: Miss Etheleen Daniel, Board of Education, Montgomery County, Maryland

Group VII—Physical and Chemical Changes

Room 105

Leader: Dr. Clark Hubler, Wheelock College, Boston, Mass.

Consultant: Mr. Haffizullah Amin, Teachers College, Columbia University, New York, New York

Group VIII—Foods and Nutrition

Room 122

Leader: Dr. Willard Jacobson, Teachers College, Columbia University, New York, New York

Consultant: Mrs. Mary Hill, Teachers College (student), Columbia University, New York, New York; Miss Myrtle Townsend, Public Schools, Camden, New Jersey

12:15 P.M.–1:00 P.M. Renaissance Room. Panel Discussion

Chairman: Mr. Joe Zafforoni

Group Leaders: Miss Marian Betar, Dr. Genevieve Bowen, Dr. Katherine E. Hill, Miss Betty Hone, Dr. Clark Hubler, Dr. Willard Jacobson, Dr. Madge Stanford, Mrs. Jessie Wall

ELEMENTARY SCIENCE FOR A CHANGING WORLD *

John Gabriel Navarra

New Jersey State Teachers College, Jersey City, New Jersey.

It is always tempting to sit back and concoct a *master-plan* which in imagination makes provision for all contingencies. The essential ingredient of a master-model would seem to be that it provides a panacea and a reliable guide to the future!

Such an approach on my part would be an impertinence. Among the group gathered here are the leaders in Elementary Science. Many with much more experience than I in planning. However, no matter who undertook to construct such a model it would be doomed to failure. There are too many uncertainties—too many unforseen contingencies which may or may not arise.

But in a pragmatic sense we do have to project educational planning into the future and fashion a guide, recognizing it will frequently be "wrong" in the sense that certain contingencies never develop. Possibly the way or, at best, the least hazardous approach to the problems of tomorrow is to examine briefly, aspects of the status of Elementary Science, i.e., as it is currently practiced in the United States.

To forecast the probable future development of Elementary Science, particular attention ought to be devoted to certain dichotomies and points of contention which seem to exist. Recognition and discussion of both desirable and questionable trends may serve a useful purpose. Through open and free discussion certain trends may be strengthened—others may be subverted and thus will never become an actual pattern of Elementary Science in the future.

ELEMENTARY SCHOOLS AND "SCIENCE-TALENT"

From numerous, diverse sources there is a growing trend to identify talent in science at the earliest possible moment. A concerted effort is being made to develop

* Paper presented at the National Council for Elementary Science Meeting, Olympic Hotel, Seattle, Washington, March 1, 1958.

various test-instruments which pin point special aptitude or interest in science.

This concern, as we all know, has been instigated by a developing shortage of research, engineering, and teaching personnel at all levels. Further impetus has been given to this work by recent publicized advances of Russia and other countries in the area of science.

Of much significance is the new awareness aroused in the public. Industry and industrial leaders in various sections of the country have had a tremendous influence in the mounting drive to press for more adequate development of the science aptitude latent in the young.

If one listens carefully, it becomes crystal clear, we are far from the peak of the pressure which will be directed toward the elementary school. Now, this is not without its compensations. The early discovery and development of science aptitude could prove to be a very valuable, significant trend. However, it would seem to be quite pertinent to raise the question as to how the aptitude would be developed. In what way, if any, would the intensive development of latent ability in science differ from our current, better programs of Elementary Science?

Since four discussionists will orient remarks around points raised in this paper, I will refrain from the master-plan approach and restrain my remarks to the following comments: Recognizing that our schools are tax supported—some adjustment must be made to the developing pressure of parental concern relating to the elementary science curriculum. Any decision made has to be scrutinized carefully to insure that it does not destroy and undermine progressive trends and facets of the elementary science program which have taken years to develop. In addition, more attention has to be devoted to making parents and other groups more conversant with the objectives of a sound elementary science program. There is an incessant cry and demand for "results." In our better programs, have we been able to pin point in the obvious, straightforward example and concrete language the "results" which the lay group demand and respect?

MONEY AND MATERIALS

A corollary to the increased concern with science in our schools in the increased willingness to expend money to achieve "results." In fact, teachers in various sections of the country are finding that school boards, school committees, PTA's, individual parents, and other groups are making funds available for the specific purchase of science materials.

Parents are expending increasingly larger sums of money for chemistry sets, microscopes, and other science "toys." An ever growing quantity of materials of this type are appearing which claim the attention of the children. In my estimation, these "toys" have exerted an influence on the thinking of the parent. This, in itself, has an impact on the classroom and the use of materials in elementary science activities.

An increasing number of queries have been coming from school committees composed of both teachers and parents concerning long range expenditures for science materials. Usually a certain amount of money has been budgeted and earmarked specifically for science materials. *And* if one is only slightly aware of events—it is apparent that there are an increasing number of science "kits" appearing to fill this demand.

One finds "kits" for weather, electricity, magnetism, machines, water-purification, ant-study, and almost any topic that can be brought to mind. There would seem to be a marked tendency to "package" science. Many times printed material accompanies the "kit" with blanks to be filled in by the children. Evidence of the workbook, cookbook approach to science is all too apparent. The implication is that the

kit or package can be given to the children and learning will occur almost without the participation of an adult or teacher. This is a subtle and, in a sense, a dangerous implication.

One of the significant trends of the modern elementary science program has always been the emphasis on simple materials—materials concocted by children and the teacher for a specific purpose. The strengths in such an approach have been expounded eloquently by many of the leaders in elementary science and possibly will be touched upon by the four discussionists. However, probably not as evident is the fact that the use of simple material denotes a rather definite approach to the teaching-learning process: a teacher and children engaged in meaningful activity and problem solving. This type of activity places a subtle but heavy responsibility upon the teacher's role as a guide and participant in the learning.

I think we ought to be quite willing to state that such an approach is much more demanding of a teacher; although quite evidently much more rewarding in terms of children learning in the area of science. One powerful check, which in many cases prevents the imaginative and adequate use of simple materials as the main-stay of the elementary science curriculum, relates to the teacher's training. Often times, the training in the area of science has been woefully inadequate in terms of developing and concocting materials with respect to an area of the children's concerns. Sensing this inadequacy—and ever anxious to do a good job—many teachers turn hastily and mistakenly to the "gimmick" or package.

One of the most encouraging signs is the rapid and extensive development of in-service training. Many of the better school systems have continuous study programs for their teachers which provide specific, practical aid concerning the use and development of science materials. However, there is an on-the-spot item which must be recurrently faced in even the best of the in-service programs: What is the balance to be struck between materials concocted and materials to be purchased?

On a philosophical basis, this is one of the easiest problems to circumvent. But on a practical basis, where should one stand?

Recognize that major errors in planning for tomorrow stem not only from faulty reasoning but from *insufficient knowledge as to what probabilities will become actualities in the future.* What will the temper of our people be in relation to our elementary science programs?

There is currently a strong drive to develop science-talent. This stems from the race with Russia. However, there are an increasing number of indications that this trend and demand will continue. There seems to be occurring a basic reorientation of people toward science education. Larger amounts of money will in all probability be forthcoming for instructional purposes in our schools. Are we to say *NOW* that elementary science programs cannot benefit from larger expenditures of money? If a program can benefit from more money—in what way can it so benefit?

DEVELOPMENTS IN SCIENCE

One need not go to scientific journals to become aware of the type of progress in science. Today as never before there is a widespread popularization of the progress in science and technology.

Pick up almost any popular magazine: Of the last 44 issues of *Life,* ending with November 25, 1957, approximately 19 carried some mention of science on the cover either in the form of a cover-picture or as a blurb in the right hand corner. One need only peruse the cover of such a magazine to be made aware of progress and astounding developments in science. If an examination of the amount of space and text devoted to science were made, the figures would be even more impressive.

Science News Letter would, of course, give a more accurate picture of progress and development in science. Articles such as "Ten Hours to the Moon" indicate quite dramatically that a trip to the moon is no longer a dream but a target toward which scientists are shooting, with a good chance of hitting it soon.

A random sampling of the weekly summary of current science, arrays before us a host of new developments:

The immediate probability of harnessing H-Power. This would bring to the world a new source of controlled power which would draw its fuel from the oceans' deuterium or heavy hydrogen.

A new operating principle for engines of the future is based on free pistons that float in their cylinders. This gives rise to the possibility that small engines will lift "flying cars." It is expected that these aerial vehicles will look much like regular cars. However, they will be flatter and wider to accomodate two to four ducted fans located in conventional positions.

A new type of oral insulin which may prevent diabetes is being perfected.

A new operative technique has been used which can replace a diseased bladder with part of the stomach.

There have been reports of experiments with a method of successful sex control in animals which is based on the electrical properties of sperm cells.

Reports of new fuels abound. An intriguing report of the use of "free radicals" as rocket fuel opens up new possibilities for travel in outer space.

A wealth of new information relating to virus research in cancer is being accumulated. There have been exploratory investigations of the virus as a medium of control, i.e., in bollworm control.

The filaments of fungi have been used as a new source for the manufacture of paper and paper products.

A new kind of steel which allows magnetism to turn corners has been developed. This constitutes a major scientific breakthrough for the electrical industry.

There have been numerous reports of the importance of plant protein in photosynthesis with the probability that photosynthesis may be duplicated by man through purely chemical means.

With what rate—with what rapidity will we move into a radically new world? A listing of the recent advances in science can only hint at the form and shape of this new world in the very vaguest of terms. Let us leave it to your imagination to envision tomorrow!

However, predominating all of the events of tomorrow will be the fact of safe interplanetary flight. To many adults such a reality is at once incomprehensible and to an extent fantastic. *What about children?* To children playing with rocket ships, space helmets, and setting space clocks by "universal star time" these events are a much relished expectancy.

The last few decades have seen our concepts changed drastically. In my opinion, our children have been affected by these events in two very significant ways: awareness and flexibility.

The popularization of science has instigated a new and basic awareness in young children. There is a marked readiness for science. A familarity with terms and ideas stemming from science comes to them in devious ways. Sources of significant information are no longer merely within the bounds of school activity. New, significant knowledge is accumulated from all corners of the larger community. The school should make more effort to capitalize on this new awareness.

The rapidity with which change and innovation have been brought about through science, in a sense, has prevented our young children from growing up in a pattern of crystallized, static culture. The children of today have grown up in a "fluid culture." One of the great strengths, in my estimation, which has resulted is that we have a more flexible generation of children—flexible children who accept change and assimilate innovations and new ideas with a willingness and speed totally incomprehensible to the majority of adults. Those trends in elementary science programs should be further developed which enhance, build on, and strengthen this growing factor of flexibility among our children.

PITFALLS TO INNOVATION

Developmental characteristics of children have become a *fetish* in curriculum construction. One has the feeling that many programs are constructed in the same old

way. Then, post hoc, allusions are made to certain developmental characteristics of children. By implication a feeling of awe and certain mysterious powers are assured for the program.

Let me hasten to say, I believe in basing the elementary science curriculum at every point on a firm, sound understanding of children. However, there is cause for increasing concern with respect to the way developmental problems and characteristics of children have been misused to bolster certain entrenched facets of the curriculum. For example, in relation to six-year-olds there is a developmental characteristic often quoted: He is capable of *simple* reasoning about things concerning his own *immediate* environment. To me the use of simple and immediate constitute qualifications which restrict, misguide and weaken a truly creative, challenging approach to a curriculum in science based on a sound understanding of children.

Let me state bluntly and categorically that the reasoning of a six-year-old under proper guidance is far from simple. Its depth and complexity are stimulated by a whole constellation of environmental factors. *And* what constitutes immediate—the moon, earth satellites or an abstraction like energy? I have worked with and have been in classrooms with six-year-olds where ideas relating to energy were pondered, experimented with, and discussed with a much greater depth and feeling than was ever engendered by a duck, pussy cat, or petunia!

One of the major problems confronting the school today is in relation to appeal and, if you please, challenge. There has often been an overwillingness to say that the child is *not* ready for this or that. There has been a tendency to over-restrict the childs' school environment by resorting to cliches not the least of which have been *superficial* statements concerning developmental characteristics of children.

As plans are made for today, and inevitably for tomorrow in elementary science, we have to be sure that a good beginning such as basing programs on the developmental characteristics of children does not turn in upon itself. When pronouncements are accepted uncritically, severe limitations are placed upon any program which may be evolved. Innovation is subverted. What *is* a useful basis for curriculum construction becomes, rather, an area which serves as a deterrent to further innovation and constructive action.

An important aspect of leadership in curriculum development in elementary science necessitates that all current practices be examined with a critical, skeptical eye. To realize that we can never rest—whatever the program is today it must be revised for tomorrow. The revisions must be imaginatively and realistically oriented with respect to the *new, accumulating knowledge of children and science.*

COMMENTS ON "ELEMENTARY SCIENCE FOR A CHANGING WORLD" *

JOHN D. MCLAIN
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DR. NAVARRA expressed a concern about the *misuse* of the terms "developmental problems" and "characteristics of children." I think there is a logical explanation for this misuse. The curriculum worker has the same kind of dilemma as a coach. To be successful a coach has to win games and a curriculum worker has to produce guides and bulletins—and these materials must be developed by a committee of teachers.

* Discussant remarks made at National Council for Elementary Science Meeting, Olympic Hotel, Seattle, Washington, March 1, 1958.

Recently I visited a school where a group of teachers had just completed an elementary science guide. They had been *assigned* the task of meeting once a month until the guide was finished. It took just two or three meetings to complete their work. The first part referred to the needs of children and the second part was the table of contents of their textbook. I never did discover which book they copied the first part from. This is just one illustration of what happens when we *force* teachers who really don't understand the needs of children to write a curriculum guide about a subject they would just as soon not teach. Too much of this is being done.

There is one consolation though—after it is once written nobody is going to use it, anyway.

Dr. Navarra quoted a characteristic of a six year old as:

"He is capable of *simple* reasoning about things concerning his own immediate environment."

I submit that that is true also about ten year olds, about teachers, about us. We learn little by little, from the known to the unknown, until we can make broad generalizations.

A number of years ago I visited a rural school in Oregon. At recess all the children ran to the creek. Each child had staked his own claim and was operating his own sluice box.

I asked a six year old what he was doing. "Oh," he said, "We are mining for gold. You must be awful dumb if you don't know that."

One time I watched an eight year old demonstrate to a group of teachers how to mount butterflies. After his demonstration each teacher was given a Monarch to mount and this child acted as a resource person to help them. Later I asked him how he liked working with teachers. "Fine," he said, "but I didn't realize they were so dumb."

As Dr. Navarra pointed out *simple* and *immediate* are relative to one's experiences. What is simple for one person may be very complex for another. Teachers must remember *that* when they are working with children. And we must remember it when we are working with teachers.

What is *simple* and *immediate* is constantly changing for all of us through mass communication and everyday living in a scientific environment. In the same way the difficulty of understanding concepts changes as awareness changes. Things which were complex theories at one time may become axiomatic through use.

For example, adults no longer question whether the earth is round or flat. World globes are introduced in the second grade or sooner.

Electronics, aerodynamics, atomic fission and many other innovations are finding their way into the elementary classroom—things which only a few years ago were too difficult even at the high school level.

Today the concepts of infinity, and time as a variable related to speed in space is too difficult for me to understand. But such things may be taken for granted by my grandchildren when space travel is commonplace.

Dr. Navarra has pointed out that rapid change and innovation has resulted in a more flexible generation of children. Yet, these children may become the "rigid" adults a generation from now. What we judge as flexibility, by our standards, may be too rigid for an even more rapidly changing future. None of us really knows what the future holds. We cannot teach the children today the solutions to the specific problems they will face in the future. But we can teach them the technique or method of solving problems.

If we can teach children to solve problems—problems which are real to them—by using the scientific method, they can develop a habit of reasonable approach to the unknown, and hence, be better prepared to face future problems as they arise.

Very few teachers have been really adequately prepared to teach elementary

science. They come out of college thoroughly dichotomized, and then, through in-service training apply this to the developmental tasks (which they don't understand either).

Somehow we must eliminate the artificial barriers which tend to impede the development of concepts, of broad relationships and interdependence. It can be done if we will only do it.

One summer I spent two weeks in a National Audubon Camp. We learned about plant succession by going to see the lichens, the mosses, ferns, shrubs, the pioneer trees, and finally the climax maple. We studied bog life and observed the effects of receding and rising water on both plant and animal life. We walked in the woods and observed the balance of nature. We talked about the decaying log—why it decayed and how it changed the soil and life around it. We predicted the weather, studied the stars, tested the hardness of rocks and observed soil erosion. We did many other things too numerous to mention.

And all the time, no matter what we were doing, we were learning about relationships, interdependence, and the dynamics of change. We were not being dichotomized, we were being integrated. I believe I developed a deeper understanding of life in two weeks there, than I did from years at college.

I wonder if the professors who taught at camp went back to college and taught the way they did at camp or if they went back to their own little department and taught the same old stuff in the same old way.

Before our teachers can do a good job of teaching, they must know how to teach and what to teach. At both the pre-service and in-service levels, we must teach the teachers in the same way we tell them to teach the children. If we lecture at them, they will go out and lecture at the kids.

We must provide first-hand experiences which are simple and immediate to them. We must give them an abundance of opportunity for learning by doing—by making first-hand observations, and experimentation.

They must learn through personal experience the appropriate use of textbooks, films, encyclopedias and other essential learning aids.

We must help them grow until they know *how to solve problems,* until they achieve a sense of dynamic change, and until they gain an insight into the deep interdependence of life and its environment.

If we can do that we will have good teachers of science—yes, we will have good teachers of children.

COMMENTS ON "ELEMENTARY SCIENCE FOR A CHANGING WORLD" *

Arnold M. Lahti

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The selection of the title for this meeting came at a very appropriate time. The Russian Sputnik I and II and Explorer have acted like a catalyst in focusing our attention on the changing world. The topic selected by Willard Jacobson could not be more timely or important. John Navarra's keynote address has given us some excellent points for discussion. I would like to discuss a couple of these points as I see them.

As John Navarra has indicated the most

* Paper based on comments made regarding paper presented by Professor John Navarra National Council for Elementary Science Meeting, Olympic Hotel, Seattle, Washington, March 11, 1958.

pressing problem stemming from the race with Russia is the drive to identify and develop science talent. As our times have been called the age of science, this problem will in all probability continue.

We should not lose sight of the fact that in our age of science and in our democratic society we need both scientists and a generally educated public. The need for a generally educated public who understands science and the role of science in our society may be the more pressing need in the long run. Ultimately, it is the people of a democratic society who must decide the crucial issues. It would be unfortunate if from the lack of understanding pure science the people of this country decided to put all their proverbial eggs in one basket of science, e.g., rockets and missiles. It is important to realize the difference between pure and applied science when discussing this problem. It is convenient to divide scientific pursuits into pure and applied research, although sometimes it is difficult to distinguish between them. The applied scientist is committed to a particular program. In general, and oversimplified, he utilizes the theories of pure science and applies them to his particular problem. Ideally, the applied scientist would bring knowledge already known to bear upon a problem and would not be concerned about discovering new knowledge or modifying knowledge. The opinion that many of us had that the Russian program was a crash program in one area, primarily applied science and not pure science, has been confirmed recently by Dr. Lertes remarks. This statement does not imply that the Russians are not also doing pure research. The pure scientist follows an "empirical guess," "intuitive hunch" or brilliant flash of imagination and tries to find another break through in the knowledge of science. This, I submit, may prove more fruitful in the long run. And, please, underline the *may*. Unlike industrial and applied research the results are not known ahead of time and, therefore, the cost for a break through cannot be estimated. The generally educated citizen must realize this aspect of science to decide issues intelligently.

It is an unfortunate commentary on our culture that we put more emphasis upon the practical results of science rather than viewing science as a source of knowledge and a process of discovery and decision making. The cultural impact is noticeable at the Ph.D. level as well as at other levels. For example, the per cent increase of engineering Ph.D.'s, an applied science, has increased more than the per cent increase in any other science area. How can this aspect of science be incorporated into the thinking of the public?

The scientists that society needs range from the pure scientist we have been discussing, to engineers, to technicians, to repairman. Anyone who has an interest in science or technology has the ability to find a niche somewhere on this spectrum of science abilities.

Are these two needs dichotomous? Are the factors involved in decision-making the same for both groups? May I suggest that they are the same and if they differ, they differ in degree, not in kind. Putting it another way, the objectives of instruction are the same for both groups. Using the terminology of Burnett,[1] these objectives can be divided into two groups called pervasive objectives and content objectives. Included among the pervasive objectives are (1) scientific method, (2) scientific attitudes, (3) appreciation and interest, (4) the social implications of science. These objectives are called pervasive objectives for the obvious reason that they are pervasive throughout the science program. Without entering into an analysis of what is meant by the terms at this time it seems quite evident that the pervasive objectives are important for persons going into science just as they are for the average citizen. If this is true, then how can the emphasis upon

[1] R. Will Burnett, *Teaching Science in the Secondary School.* New York: Rinehart and Company, Inc., 1957.

the education of science talent be any different from the education of the future citizen?

If we agree that the pervasive objectives are important for all the students who graduate from our schools then the question becomes one of implementing the objectives through the selection of content and the procedures for handling the content. The pressure exerted for science talent should strengthen the elementary science program conceived in terms of objectives. If we have not been doing as well as we should in the implementation of the objectives, how can the implementation be improved? It seems as if the elementary science program must be improved through the selection of content and the procedure for the teaching of that content. Let me change that. It isn't the procedures for teaching content but rather the selection of procedures which will enhance the drive, interest, motivation and therefore the learning of the content by the child, as well as growth in the ability to use, appreciate and understand the pervasive objectives.

A decision concerning the implementation of objectives must be made with the realization that there are individual differences within the class. Less emphasis has been given, apparently, to the better students in the class. Therefore, the pressure upon the school has been to do more for the gifted child and the better than average child. What are the psychological and sociological characteristics of the children at a given age level who are above average? What are his interests? What kind of questions does he ask? How do these characteristics, interests, and questions differ from the other children? These are crucial questions to ask ourselves. Our answer to them will have a great deal to do with our prognostication of the future. In any case we must focus our attention on the children in the classroom. This is not, I am sure, a disagreement with John Navarra, but rather a point of emphasis. If I understand John correctly he maintains that the children are interested in, can reason about and understand concepts such as energy, etc. We agree that questions dealing with the physical environment may be as interesting if not more interesting than questions dealing with pets or other objects.

This brings us to our major problem. How can we more adequately help the children to ask questions about their environment and to help them answer the questions they ask and formulate? May I suggest that the answers to the question be couched in a realistic and sound understanding of children. Not only for reasons which have been discussed already but because there is a tremendous distinction between (1) telling the children the answers, particularly the "right" answers and (2) having the children find answers and understanding their answers.

I know a five year old who was saying something about the earth being round. I asked the boy how he knew the world was round? He said, "A jet could take off and 'go round' it." This is pretty good. The answer is exactly the same in form as the statement, "Magellan's ship sailed around the world and proved the earth was round." For younger children this is good reasoning. For older children one might ask whether this is really proof. Couldn't Magellan have gone around a cylinder?

Looking back upon the influence of television upon the environment of the boy, one can see that there are reasons why he might accept the roundness of the earth. The earth is always round on the television screen. There are advertisements showing airplanes going around the earth. Therefore, the reasoning may not be quite as good as the answer implied. It was probably the use of information which was available. But after all we must live with the information that the children have at their disposal from other media, and change our teaching accordingly. The physical environment is certainly changing, and, therefore, it is pertinent to ask, "What aspects of the physical environment should be included at the various levels of an elementary science pro-

gram? What kinds of larger problems should be included in the elementary school and how can the objectives be implemented?"

There is one explicit proposal which I would like to submit for your discussion. It is one which I have discussed before and does not pertain to the larger problems, but is one small step toward broadening the children's base of experience. Although scientific progress and the progress made by society is a cooperative one, each step forward requires the individual questioning of some one person. Therefore, individual experiments should be included in the elementary class. Let me hasten to add that by experiments I do not mean finding the answer in a book. An experiment is a problem which must be answered by manipulating material and drawing conclusions from the data that are collected. Neither do I mean that the steps for manipulating the material be stated. The experiments must be ones which members of the class can manipulate and solve. The individual experiments seem desirable because of individual differences and also for the development of pervasive objectives. Likewise, for the students who are not going to be scientists the individual experiments seem desirable because it will show the difficulty of phrasing the question in such a way that it is an answerable question. Furthermore, the designing of an experiment, that is, the plans for manipulating the material and the correlating of the observations is a procedure which will teach for the pervasive objectives—scientific method and scientific attitudes. Also, the individual experiment may indicate to the general public the major difficulty in science research—asking the right question. This is the aspect which, even though funds are appropriated, may keep progress in science from being made.

One of the important questions the classroom teacher would ask is, "How can it be done in the crowded classroom?" Another might be, "How can all the students participate?" We all agree, I'm sure, that a laboratory period for everyone is not the answer for an elementary school. The science corner has been used, particularly in the primary grades, for exploration of objects and manipulation of materials. Perhaps, the science corner can be adapted for the individual experiments. Materials can be placed upon the science table. Along with the materials is included a sign which asks the question to be solved by the manipulation of the materials.

One of the important problems in a classroom is to have experiences, reading materials, etc., for the wide range of individual differences which are found in any classroom. Can experiments be found which can be set up in the science corner or on a table so that children who have completed other work may spend some time trying to solve the problems? Note that this implies that every child need not solve the problem. This seems just as appropriate as allowing the child who is finished to read, draw, use clay, or do some other activity. If the children are interested in this sort of thing they must actually ask questions and design experiments to answer the question. This is the crucial aspect of scientific discovery and, parenthetically, creativity in any area of human knowledge.

In attempting to amplify those that are, to me, the most provocative problems which were suggested by Navarra, I have neglected some of the others and have tried to emphasize the implementation of objectives. It is this aspect of the program which is crucial for the development of science talent and for the development of an understanding about scientific research by the citizen. The discussion of individual experiments and objectives was introduced to suggest that, along with problem solving in larger units such as the I.G.Y., the question of science talent versus the science education of the general public can be handled in the same class. To the effective teacher who is cognizant of the individual differences

which we know occur in the class, the problem of science talent versus general education, or the above average and gifted versus the rest of the children becomes a meaningless dichotomy.

The discussion groups will have an opportunity to discuss any of the important problems which have been introduced by Navarra's keynote address. But remember, although we may discuss and generalize, that which is successful in the classroom with the classroom teacher will prevail. The sharing of your experiences will add a great deal to the discussion in the afternoon.

COMMENTS ON "ELEMENTARY SCIENCE FOR A CHANGING WORLD" *

E. BERNICE OWENS
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MR. NAVARRA has raised some very pertinent questions which I feel are related to the most crucial problems that we face in our efforts to develop the type of elementary school science program needed today. I find the entire paper highly provocative, but I consider the section entitled, *Elementary Schools and "Science-Talent"* especially significant and timely.

I am happy to note that Mr. Navarra enclosed the term, science-talent, in quotation marks. Since the pressure groups of which he spoke are so glibly tossing that term about, perhaps we should consider its meaning. In speaking of talent in the field of art, Mendelowitz says, "The talented child, simply enough, is a child who has received, for one reason or another, sufficient satisfaction from a certain kind of activity to participate in it more frequently and with more intensity than do most of the children in the same age group and so has developed his capacities beyond the average of his group. When a child receives intense satisfactions from an activity, . . . an ego-centered cycle of dynamic development is set up. Increased activity creates above-average performance, which results in more satisfaction, which results in more participation. Before long the child's abilities have developed far beyond those of most children and consequently the child has a greater interest in the activity than do most children. This is called talent." [1] I agree with the pressure groups that discovering talent is important, but it seems to me that they are putting the cart before the horse when they urge us to *discover* talent so that we can *develop* it. It seems that we are in danger of losing sight of the fact that we should first provide opportunity for a degree of development.

The world of science today is making so great an impact upon the children that they cannot escape it. We know from casual observation that all healthy, normal children are active, dynamic, in quest of new activities, and seeking new information concerning the natural phenomena and the scientific developments of their world, but studies of the kind done by Mr. Navarra and his wife, on their child, point up this fact even more vividly. If our schools will provide opportunity for all children to pursue their scientific interests, those children who gain intense satisfaction from the science experiences will have the opportunity to develop science-talent. I feel it important that all children have these op-

* Discussant remarks made at National Council for Elementary Science Meeting, Olympic Hotel, Seattle, Washington, March 1, 1958.

[1] Daniel M. Mendelowitz, *Children Are Artists.* Stanford, California: Stanford University Press, 1953, p. 11.

portunities since the studies done by Strauss seem to offer conclusive evidence that the "science-talented" is not necessarily the individual who has a high I.Q. nor the one who makes high marks in school.

At the same time, it seems important that we heed such warnings as: "Science alone will not save us," and "We are in danger of selling our birthright for a mess of pottage if we make the development of scientists our prime objective." Should we not strive to provide opportunity for the development of numerous and varied types of talent by thinking of our science program only as an integral part of the total elementary school curriculum?

Mr. Navarra cautions us to scrutinize carefully any decision made in our attempts to meet the incessant cry and demand for results "to insure that it does not destroy and undermine progressive trends and facets of the elementary school science program which have taken years to develop." Then he asks. "In our better programs, have we been able to pin point in the obvious, straightforward example and concrete language the 'results' which the lay groups demand and respect?" It seems to me that we face an unprecedented challenge to use the limited research which we have and to undertake further research in an all-out effort to salvage the best trends and facets of our present program and to use them as a nucleus to develop a program which will produce obvious results. As I have observed teachers laboring under the pressures of recent years and of recent months to teach more science and as I have observed groups becoming frantic about the demands to screen and give special education to the "gifted" child, I have often felt that we are in grave danger of losing not only the best facets of our science program but of our total elementary school program. So, I feel that the pressure to emphasize science offers us a rare opportunity to help preserve and to build on to the best that we have in both of these programs by making science an integral and basic part of the total elementary school program. I also feel that N.C.E.S. should utilize this opportunity. I feel that the importance of developing such an elementary school program is substantiated by some of the generalizations which Strauss drew from his studies, viz: (1) The successful scientists must have the ability to get along with others; (2) Our most successful scientists lead normal, well-rounded, well-balanced lives, and (3) they are happy in their chosen work. If there is any validity in the research which we now have; if talent is the result of a long background of satisfactory experiences in a given realm of life; if there is sound basis for the attitude expressed by many that science not only elevates the condition of man in a technical sense, but it also lends itself to service in a social sense, can we not conclude that a good science program for the elementary school can exist only as an integral part of a rich total school program based on the best that we know about human growth and development? Is this the only way we can produce a generation of people who "work with love" and who take pride in a job well done? Is it the only way we can produce schools of the type to which Mr. Navarra refers when he speaks of "a teacher and children engaged in meaningful activity and problem solving"? Can we convince those who hold the purse strings that it is only through developing a rich, sound, well-balanced total elementary school program that we can build a solid foundation for the cone, the apex of which is science specialization in secondary school and college? This leads to the next section of Mr. Navarra's paper which is entitled *Money and Materials*

Recent literature reiterates Mr. Navarra's statement that a corollary to the increased concern with science in our schools is the increased willingness to expend money to achieve "results." In fact, we have accounts of lay groups giving also of their time and talents to support elementary science programs. Mr. Navarra concludes this sec-

tion of his paper by asking, "If a program can benefit from more money—in what way can it so benefit?" I certainly do not propose to answer this or any other question which he has raised, but it seems to me that there is a dire need for more money to improve our preservice and inservice program in a way that will make the classroom teacher more able to discharge the "subtle but heavy responsibility" which is his in the "role of a guide and participant in the learning process," as discussed by Mr. Navarra. Recently I have been flooded with literature announcing special workshops, sponsored by the National Science Foundation and other groups, for secondary science and math teachers; but only one such workshop for elementary teachers has come to my attention. Mr. Navarra mentions the fact that there has been rapid and extensive development in inservice training, but it seems there is still a desperate need for more of these programs in order that we may better cope with the workbook-cookbook-package approach to science which I feel precludes the possibility of making science as an integral part of a sound total school program.

The science toys and kits are with us and we have to deal with them. In fact, it seems that some of them can be used to advantage. Some of these kits go into the field of cybernetics, a field which most of us are totally incompetent. The fact that science is reaching out into new fields of that kind means that we need better and more extensive inservice programs, not only for the elementary school classroom teacher but also for those conducting the preservice and inservice programs for those teachers.

In order to combat the tendency to make a fetish of basing our science program on the developmental characteristics of children, we need preservice and inservice programs which will help teachers to become more sensitive to each child's perceptioin of his world, more sensitive to the impact this world is making upon the child, more sensitive to the contingencies of today's world, and more able to become flexible along with the child. Mr. Navarra refutes the idea that the reasoning of the six-year old is *simple* and concerned only with his immediate environment. Some of our older studies support his stand, and because of the increased awareness and flexibility of today's children, which Mr. Navarra discusses, these children are even more eager and more ready to delve into the complex and advanced areas of science to the extent that many of them are doing so on their own outside of school.

Helen Lawrence Merrill states that "the science teacher in action in the secondary school has the opportunity to revitalize the wonder of the first grader into the scientific interest of the adolescent by presenting an orientation image as the basis for questions leading to a concept image. Student answers to these questions, by experiment, research, or other method should then be made possible." [2] Can we nourish this wonder of the young child, increase its intensity and its scope if we guide him in seeking answers to his *own* questions by experiment, research, and others methods *all the way through the elementary school* instead of restricting his experiences to the *simple* and *immediate* and in so doing make it necessary for the secondary teacher to revitalize this wonder?

Merrill continues: "The provision of resources and direction of action are facilitated by the teacher. The climax is reached, however, by the formation of a concept image as a result of the group dynamics. Here a common understanding is reached even though the image in the minds of the young people may differ in size or other details. Nevertheless, it is here to stay, for it does not depend on memory but upon something more vital and usable." Do not some of our better elementary schools of today exemplify this way of working with children? Merrill then concludes: "All

[2] Helen Lawrence Merrill, *The Science Teacher in Action*. Boston: The Christopher Publishing House, 1956, pp. 56–57.

achievements that have taken place in this complex world of ours have taken place first in the mind of man, and so the images have become realities. Man has seized upon these realities to use them as the basis for further developments; thus the visions of man become the realities of life and in turn these realities become the images that light the way to new realities."[3] If we nurture the wonder of the elementary school child and constantly help him to broaden his horizons, will we not at least lay the foundation for these visions? If we become adept at utilizing parents and other resource people, they will be closely tied to our program and will become increasingly aware of the child's tremendous capabilities, or perhaps this principle will work in reverse. Perhaps many of the parents do not underestimate the child so much as we teachers often do. Whatever the case, it seems that the more the parents observe the child's achievement, the more support they will give to the program which allows opportunity for those achievements. Can we point to elementary schools which nurture and vitalize the wonder of the child? Can we liberate ourselves from the pressures to "educate the gifted" and to "develop science-talent" by producing more and more programs of this type and at the same time produce the quantity and quality of scientists needed?

[3] *Loc. cit.*

SCIENTIFIC ATTITUDES POSSESSED BY JUNIOR HIGH SCHOOL STUDENTS

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THIS study was conducted at Oswego, New York. The project was undertaken to determine what junior high school students understand about science and its approaches to problems.

The questionnaire was presented to one hundred and twelve eighth and ninth grade students. They were conditioned to answer the questions as they felt they should be answered. To achieve individuality and opinion, the students were told that the tester would not read the papers; rather the papers would be used by a group of teachers who were studying what should be taught in science.

The structure of the response system was designed for facility in answering and checking. Three responses were possible, arranged in a column at the right of the given statements. A student had a choice of answering true, uncertain, or false to each statement. The group being tested was cautioned on answering "uncertain" too frequently. They were told that the test was designed for a minimum of "uncertain" responses.

The sampling consisted of twenty-five statements. Check statements were included to rule out invalidity of statements. This paper does not intend to reveal any pat conclusions. It is rather intended to give science educators more insight into how youth feel about science.

Following are the statements presented in the sampling. They are not in the order as presented. Check statements were scattered throughout the paper. The percentages listed are rounded off to facilitate significance.

The author is not presenting any comments until further testing is completed.

The vocabulary and structure is of a nature thought best to elicit understanding from junior high students. Intelligence quotients ranged from 70 to 132, with a reasonable distribution.

UNDERSTANDING NATURE OF SCIENCE
(Title not in Test)

	T	U	F	N.A.
1. Science is the study of everything.	86	1	13	0
2. Science explains why everything happens.	55	5	38	2
3. Science is a way of thinking.	98	0	2	0
4. Science is a way of doing something.	86	5	9	0
5. Science only describes and does not tell why something happens.	9	7	84	0
6. The study of science will explain anything that happens on earth.	61	7	30	2
7. Observing anything is a scientific way of doing something.	86	5	9	0
8. If a scientist discovers something as true, we must believe it.	14	5	81	0
9. A true fact can never be changed, no matter what.	53	5	40	2
10. Science is a difficult subject.	58	7	35	0
11. American science is different from science in the rest of the world.	6	13	81	0
12. Physics includes the study of physical education.	16	6	78	0
13. Nature includes everything, living or non-living.	68	2	30	0
14. Happiness can be measured scientifically.	25	22	51	2

UNDERSTANDING THE NATURE OF THE SCIENTIST
(Title not in Test)

	T	U	F	N.A.
15. Scientists would make good politicians.	14	39	47	0
16. When any scientist discovers something, he is happy because he may become rich.	13	14	73	0
17. All scientists seem to be working to destroy the earth.	7	2	91	0
18. The world has been made less safe because of the work of scientists	23	16	61	0
19. Because of the satellite, it appears that Russian scientists are better than American scientists.	28	9	63	0
20. An engineer is a scientist.	65	9	26	0
21. A scientist is an engineer.	55	9	36	0
22. A television repairman is a scientist.	64	7	27	2

MISCELLANEOUS
(Title not in Test)

	T	U	F	N.A.
23. The hydrogen bomb will someday destroy the earth.	20	60	18	2
24. It is believed that life began as a one-celled animal.	70	13	17	0
25. Life is possible without plants.	33	2	65	0

DESCRIBING THE EFFECTS OF EXPERIMENTATION IN TEACHING SCIENCE AT THE EIGHTH GRADE LEVEL *

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SCIENCE today in the elementary school is no longer concerned primarily with the presentation of facts. The emphasis is on the teaching of principles, the developing of scientific attitudes, and on training in the elements of scientific thinking. These are the major objectives of most of the science courses at the elementary as well as the high school level. These major outcomes are not secured accidently or incidently but can be secured only by desirable methods of teaching and a complete understanding of the effects the resultant learning has upon each individual child. A great deal of evidence points to the fact that the conventional types of teaching and materials are being replaced by procedures of enrichment and supplementation of content and materials.

* Based on the author's thesis. "Describing the Effects of Experimentation in Teaching Science at the Eighth Grade Level" completed in partial fulfillment for the Master of Arts degree at Roosevelt College, Chicago, Illinois, 1954.

STATEMENT OF THE PROBLEM

There has been a great deal of discussion as to the relative merits of experimentation by the student, as opposed to the lecture-demonstration and the textbook recitation methods of illustrating scienctific principles and generalizations. Some authorities contend that experimentation in the laboratory involves "learning by doing"; therefore, there is no substitute for it. Other authorities feel that the lecture-demonstration method and the textbook recitation method can be as profitable as the experimentation method with less required effort, time, and money.

It will be the aim of this investigation to determine which technique is most effective in helping children understand scientific generalizations and principles.

INTERPRETING THE PROBLEM

In earlier years elementary science was largely known as "nature study." It is only recently that science, as science, has won its place in the elementary school.

According to Slavson and Speer [1] the methods of teaching elementary science from the earliest days to the present time can be differentiated into four main periods. First came the recitation period. This was followed by a period when the discussion method came into prominence, and in which the teacher and children discussed the contents of the course. Both methods were verbal in nature. The third method was that of object teaching. It was believed that by coming in contact with the objects the children would have a better understanding of the content of the text. When the idea of child activity assumed an important role in educational thought, the fourth period came into being. During recent years the laboratory method has been modified. Individual interests of children are recognized, and the recitation as it is commonly understood has no place.

[1] S. R. Slavson and Robert K. Speer, *Science in the New Education*, pp. 15–16. New York: Prentice-Hall, Inc., 1934.

More recently the search-discovery method was introduced. According to this method the entire content of the science curriculum of the elementary school is initiated personally by the child.[2]

Generally speaking, authorities seem to agree that there is really no set method for teaching elementary science. One of the above named methods or a combination of these methods may be used depending upon the particular teaching and learning situation involved.

RELATED STUDIES

Extensive searching through volumes of literature dating back five decades in an attempt to locate studies similar to the one being presently described, proved interesting but futile. A doctor's thesis written by Jacob Edwaurd Mayman at New York University in 1912 has been the only experimentally controlled investigation at the elementary school level found that resembles the present study. It is true that the philosophy of science education, at the time the above work was completed, differed from the present curricular trends in science. However, the findings tend to illustrate a controversy that still exists; that is, the problem of methods and their relative importance in teaching elementary school science.

The reader needs to understand the relation and similarity of the term "textbook recitation method" which this author uses, and the term "lecture demonstration" which has been used in other studies both at the elementary and the secondary levels. The present author has chosen the words "textbook recitation method" for a number of reasons, chief of which was that it most accurately describes the control method used to eliminate as many variables as possible from the study.

Thus, both groups in this study followed the textbook recitation procedure and the variable of experimentation was used in the experimental group. Secondly, many teach-

[2] *Ibid.*, p. 290.

ers at the elementary level, having a poor background in science tend to rely a great deal on the textbook and recitation that result from its study. The relation of the studies which follow to the present study will be clear if the reader will constantly recall the similarity and interchangeability of the method called "textbook recitation and lecture demonstration."

It is interesting to note that this early study by Mayman is one of the few studies of this kind produced at the elementary level. Mayman carried out an experimental investigation of four different methods of teaching science at the elementary level: the book method, the lecture method, experimental method, and the experiment-notebook method. The problem of the study was to determine which one or more of these four methods is best from the point of view of efficiency, economy, interest and permanency, for the purpose of teaching elementary physics to elementary school pupils.

In a recent reply to a letter concerning related studies, Dr. Wilbur Beauchamp writes, "studies at the eighth grade level are practically non-existent, however, studies at the ninth grade level are applicable to the eighth grade." Accepting this premise it will be necessary to re-examine the methods involved in this study and show how they can be related to studies at the ninth grade level, before these studies are presented. In most of the studies at the ninth grade level the authors have set up an experimental situation in order to compare the progress of children studying science by two different methods. One group would study a particular unit of work by listening to lectures and watching demonstrations; the other group would listen to lectures but they would be active in performing the demonstrations individually.

The evidence that can be brought to bear on the relative values of methods in teaching elementary science evidenced both from controlled studies, and from general observation, is inconclusive. Perhaps the problem will always remain so. However, it can be expected that awareness of the problem, and further studies of it, will stimulate all conscientious teachers to re-examine the facts and observe with scientific care many new facts not yet reported as to the conditions under which the two methods yield optimum return. Only after repeated careful compilation and recording of facts has taken place will the solution of the problem be at hand.

THE PROCEDURE EMPLOYED

This investigation extended over a period of two months. Three classes of eighth grade children of Palatine Junior High School participated as subjects in this study. One group of twenty-four children was formed from two of the classes to pair with a group of twenty-four from the third class. For future use the former group will be known as the control group, and the latter as the experimental group.

The unit for research was selected from the textbook used in the school at that particular time.

PAIRING OF GROUPS

Several methods for finding the equivalent groups were employed; random selection, that is, chance arrangement; general ability; composite of several test scores; and other multiple bases, such as chronological age, and mental age.[3] An attempt has been made throughout the entire study to control all essential factors except one variable which has been manipulated with a view to determining and measuring the effects of its operation.

A total of three tests was used to compile data relative to mental age, intelligence quotients, socio-economic standing in the peer group, and achievement in science.

[3] Carter V. Good, A. S. Barr, Douglas E. Scates, *The Methodology of Educational Research*, pp. 501–502. New York: Appleton-Century-Crofts, Inc., 1941.

TABLE I

STATISTICS ON EQUATED GROUPS COEFFICIENT OF CORRELATION

Variables	Mean X	Mean Y	Standard Error		Correlation
Chronological age	13.58	13.54	.39	.44	.87
Mental age	15.10	15.10	1.64	1.66	.99
Sims score card	19.0	22.0	3.9	4.0	.80
Achievement test age eq.	11.41	11.66	1.18	1.29	.79

X=Control group.
Y=Experimental group.

DESIGN OF THE STUDY

Two other tests used in the study were given after the equivalent groups were made. An attitude test prepared by Mr. Stanley Barber Brown [4] was administered before and after the study to measure any change in the scientific attitudes of the students. A Pre-Test prepared by the Scott Foresman Company, was given prior to the beginning of the study to determine to what extent each child had mastered facts relevant to the unit under consideration.

Both the control group (X) and the experimental group (Y) were divided into six groups of four students each. This grouping was necessary for economy of materials used by the experimental group. Each group used five weeks, meeting forty-five minutes daily during a five day school week, to study the unit. Each group met early in the afternoon with the experimental group immediately following the control group; consequently, there was little difference in the time of day when the two groups met.

The control group and experimental group were given the same directions and the same materials each day during their entire endeavor. Daily assignments appeared on the chalk board. Each group worked directly from the text book. This work involved reading an assigned number of pages and answering the questions in a self-testing exercise afterward. This was followed by an objective test and assignment sheet given after each sub-problem was completed to measure the applicability of the concepts learned for each major sub-problem. Concomitantly the experimental group performed the ten experiments accompanying the unit. This afforded extra time to the control group which was devoted to other activities such as preparing an aquarium, terrarium, etc. One member of each group in the experimental group recorded the observations and data, the second read the instruments, the third and fourth students performed the experiment. For each experiment the duties within the groups rotated.

In addition to the tests on each sub-problem, a final examination was administered to evaluate the child's progress and the degree to which he had learned scientific generalizations presented during the unit study.

Throughout the entire study the writer attempted to keep all factors constant with the exception of the one variable which was measured. The experimental group alone performed the experiments.

Both the control and experimental group used the same textbook, *Science Problems I* by Beauchamp, Mayfield, and West. This eighth grade text covers a year's work in science arranged in ten units.

The experiments performed by the experimental group are listed in the order in which they appeared in the unit *How Do We Use and Control Fire.*

Experiment 1. What happens when magnesium burns?

[4] Stanley Barber Brown, "Science Information and Aptitudes Possessed by California Elementary School Pupils," unpublished Ph.D. Dissertation, School of Education, Stanford University, 1951.

Experiment 2. What happens when iron rusts?

Experiment 3. What happens when a candle burns?

Experiment 4. How are coke and gas made from soft coal?

Experiment 5. How does a fire get its supply of oxygen?

Experiment 6. How does a chimney help a fire burn better?

Experiment 7. How is a gas burner regulated?

Experiment 8. How does carbon dioxide put out a fire?

Experiment 9. How does carbon tetrachloride put out a fire?

SUMMARY AND CONCLUSION

The problem of this thesis was, "Describing the Effects of Experimentation in Teaching Science At the Eighth Grade Level."

The main source of data for this investigation was made available by an experimentally controlled study of two equivalent groups of children for a period of three months. The resulting scores of this investigation were tabulated and analyzed.

The first problem analyzed in this investigation was one of content. Content was measured by the scores of the ten self testing exercises, the four final tests, and the final examination. It was discovered that children in the textbook recitation group learned the concepts associated with the unit generally as well as the children in the experimental group. A slight difference of nine-tenths of one point was recorded as a variation between the two groups. The average of the means for both groups shows a score of 82.9 for the control group and a score of 81.9 for the experimental group which further indicates that each group worked diligently throughout the study.

The second problem that was considered in this investigation was that of attitudes. An examination of the t-ratios and the means of all the scores made by the children in both the control and experimental group on the attitude tests showed that there was not a significant change of scientific attitudes in either group. The scores before and after the study, within a few points, are almost identical. A definite change was recognized by the investigator in the child's appreciation for the scientific way of thinking. The group doing the experiments displayed a positive growth in this respect. Comments as: "Why do you think you're right," "you're not supposed to guess," "find out for yourself," and "could it have happened anyway," were not uncommon. The degree to which this growth took place was not measured because of the difficulty of determining the growth of the group not performing the experiments, in this instance the control group.

Considering the scores made by the children in both groups it would be correct to assert that neither the control nor the experimental group excelled in their ability to apply, to everyday situations, what they had learned. An average of the means taken from the raw scores made by the children of both groups on four different assignment sheets illustrates that each group had an average of 78.4.

This study has revealed, contrary to popular belief, that the textbook recitation method and the experimental method are both equally as effective in imparting knowledge and improving scientific attitudes of children studying science at the eighth grade level. The following conclusions concerning the advantages of the textbook recitation method, however, seem justifiable:

1. The textbook recitation method requires less time on the part of the teacher in preparation than the experimental method.

2. The textbook recitation method requires less time of the student in solving his problems than the experimental method. The extra time can be spent on extra-curricular activities.

3. The textbook recitation method facilitates the handling of individual differences that the children possess in science. The

setting up of laboratory equipment tends to discourage this important objective.

4. The child that is taught by the textbook recitation method has an opportunity to gain more factual knowledge than one taught by the experimental method, because of the time required in the latter method.

5. It is more economical to use the textbook recitation method in teaching science. Many of the simple materials necessary for experimentation are very costly when bought in large amounts.

The experimental group seemed more interested at the beginning of the unit but this enthusiasm was based on novelty and soon disappeared.

No positive conclusions can be reached from this study. The overall evidence indicates that both the textbook recitation and experimental methods of teaching science at the elementary school level are efficient. Science can be taught by many methods, but careful adherence to scientific attitudes and scientific methods must be constantly employed in the technique of any teaching method. This has well been summed up by the National Society for the Study of Education:

> Of all the methods that have been proposed for use in the elementary school, one method must have first consideration in the teaching of science, namely, the scientific method. Within the comprehension of the children, the application of the scientific method is a matter of securing the correct explanation, or, if that is not definitely known, of finding the best explanation. It is evident that children do not discover new facts for mankind; but they do discover new facts for themselves and they must do that day by day if they are to become fully equipped for the age in which they live. Fortunately they have the assistance of the rich scientific heritage provided for them by the scientists of the past and the present.

PALATINE ELEMENTARY SCHOOL SCIENCE ATTITUDE TEST

Name ....

Age....... Grade....... Boy....... Girl.......

School ....

Date ....Teacher ....

This is a test of science attitudes. Your score will *NOT* affect your school grade. Answer each question. Please do the best you can.

Directions: Read each question carefully. Choose the ONE answer that you think is correct. Then write the number of the answer you chose on the line to the right. Do not spend much time on any one statement. Be sure to answer every item.

1. Seeing a black cat crossing the street in the evening is a bad sign.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
2. Our own feelings are more reliable than scientific facts.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
3. Science has brought us more evils (harm) than good.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
4. Science has made our life so complicated that living is unpleasant.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
5. Scientists should cooperate with scientists of other parts of the world and work together in an intelligent way for the welfare of all peoples.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
6. Our scientific achievements should not make us disregard other nations.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
7. People should think of number 13 as an unlucky number.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
8. Scientists study accurately what they see and do not allow personal opinion to influence their reports.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
9. We have gone as far as we can go in scientific discoveries.
   1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
10. Peoples of the white race are superior to other races because of the differences in blood.
    1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——
11. Our civilization owes a great deal to scientists.
    1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

12. The human body is more complicated than any machine invented by scientists.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

13. Because of his intelligence, "man" is capable of living without any plants around him (natural environment).
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

14. Because of scientific discoveries it is not important if we are careless in protecting the forest, wild life, etc.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

15. Other living things are necessary for man's existence.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

16. A few thousand acres of forest burned over every year are not important because California has large areas of forest land.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

17. We should concentrate completely on developing atomic power as a destructive weapon.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

18. Scientific research and practices beneficial to mankind should be shared among peoples of all nations.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

19. Diseases are sometimes caused by evil (bad) spirits.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

20. The government should provide more inspection of food products.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

21. We should buy the things we need according to radio advertisements.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

22. Girls need outdoor exercise as much as boys.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

23. Science can be an interesting school subject.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

24. Man's idea about truth can be changed.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

25. The discoveries we study in science have been produced by men of many nations.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

26. We should not accept radio advertisements as being true until we have tested them.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

27. America has the only great scientists in the world today.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

28. More attention should be given to the development of atomic power to improve our living conditions.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

29. The causes of tornadoes, electric storms and lightning are known to scientists.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

30. Because of scientific progress it is not important to be concerned about the soil and water supply in Palatine.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

31. Science can be used to produce better conditions for all people.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

32. Because of the large number of deaths caused by machines (automobiles, airplanes, factories, etc.) we should do away with them.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

33. Home made medical practices are not usually the most effective.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

34. Science can do something to prevent floods and fires that destroy much property.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

35. Wild animal life should be destroyed.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

36. Girls need outdoor exercise as much as boys.
1—strongly agree; 2—agree; 3—undecided; 4—disagree; 5—strongly disagree..——

DEVELOPING PROBLEM SOLVING BEHAVIORS IN ELEMENTARY SCHOOL CHILDREN

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Science teachers are aware that the kind of individuals we wish to develop for a democratic society is dependent upon the interpretations those individuals understand as growing children. Our profession is devoted to deliberately devising situations within an educational program for the purpose of changing behavior in a particular direction: toward the improvement of the individual, school, and society. Problem solving activities in science may be planned to contribute to desirable changes in behavior in elementary school children.

What kind of problem solving experience is desirable for children in elementary science? Experience may be defined as responses individuals make to certain stimuli which result in the modification of subsequent behavior during the processes of growth and development. But such a definition describes all experience. Educative experience is reconstructive and may be differentiated from experience of just any kind by the inclusion of certain qualities. What are these qualities which distinguish educative experience and contribute to desirable changes of behavior in children?

John P. Wynn[1] states that educative experience includes certain qualities such as motivation, creativity, selectivity, relativity, unity, and sociality. Although the relative importance of the qualities determine the desirability of experience, as science teachers we could ask ourselves the following questions in selecting and planning desirable science experiences.

(1) Will the experience provide a state of affairs which will initiate and maintain interest in science?

(2) Will the experience widen or reconstruct past experience and present knowledge?

(3) Will an opportunity be provided in the experience for intelligent selection?

(4) Will the experience consider both the individual and his environment?

(5) Will the experience involve reflective purpose on the part of students and teacher?

(6) Will the experience widen or extend social participation?

The six questions consistent with the features of educative experience are not intended as a criteria to follow. Moreover it is not proposed that each elementary science experience should include all qualities. The questions indicate that certain qualities are present in desirable experience and science experiences for elementary school children may be planned to include one or more such qualities.

Providing the qualities are useful for planning science activities, a second question arises. What are the characteristics of elementary science activities relative to educative experience? In approaching the characteristics of such activities consider the familiar steps of problem solving. The basis for thinking in science is also valuable for teaching in science.

Science teachers agree that: (1) recognizing and defining a problem; (2) collecting pertinent information relative to the problem; (3) formulating a tentative hypothesis with limited information; (4) testing the hypothesis by obtaining information from books, authorities, and experimentation; (5) organizing and coordinating information for the purpose of discovering relationships; and (6) drawing conclusions, are the simple steps of problem solving which hold many potentialities for teaching

[1] John P. Wynn, *Philosophies of Education from the Standpoint of the Philosophy of Experimentalism,* New York: Prentice-Hall, 1947, pages 22–23.

children. However the steps have little meaning for children of elementary school age. On the other hand they become increasingly valuable to the teacher and pupils when related to the qualities of educative experience.

We strive to teach our children to become more sensitive to scientific problems, learn how to collect information, develop skills in testing, organizing, and coordinating data, and increase their competency in reaching conclusions by discovering relationships. In planning problem solving activities which include the above steps relative to the qualities of educative experience, perhaps the following questions will be of value to the teacher in the elementary science classroom.*

(1) Does the activity begin with a problem situation rather than a problem? One state of affairs which will motivate children in science and give them practice in becoming sensitive to problems is a situation which involves a problem to be solved, rather than a problem previously stated and answered by either the teacher or pupils.

(2) Does the problem evolve from student activity? Children will have a better opportunity to do creative thinking when allowed to collect their own information through teacher direction. Such practice has value in widening or reconstructing past experience and present knowledge.

(3) Does the activity contain familiar and unfamiliar elements to the pupils? Intelligent selection is a quality of educative experience we wish to develop in children. Learning to formulate tentative solutions for problems will be increased when the problem situation not only involves the unknown, but contains familiarities to the child.

(4) Does the activity consider the common knowledge possessed by students? The individual and his environment might well be considered in planning science experiences for children. Upon such a basis the collection of information relative to the problem from reliable sources is more effectively initiated and maintained by the pupils. Children ask a great many questions relative to their surroundings. When possible such questions may be used to direct the further thinking of children on a particular problem.

(5) Is the statement and discussion of the problem related to teacher pupil questions? Science activities planned with reflective purpose on the part of teacher and pupils, not only involve purposeful unity during the investigation of a problem, but encourage children to organize and coordinate data in discovering the relationships present.

(6) Is the problem capable of being answered through student activity? Reaching intelligent conclusions by working together is a most important quality for children to develop in a democratic society. Sociality is present in educative experience. When science activities are planned to promote social participation, as a result of group thinking, better conclusions are more likely to be reached.

When it is possible to include one or more problem solving characteristics in elementary science activities on the basis of educative experience, certain problem solving behaviors will become more evident in pupils. Science teachers may then observe pupil behavior in terms of the planned experience as related to the steps of problem solving.

* These questions were part of a course entitled, Special Problems in Teaching Elementary Science, conducted by Dr. Donald G. Decker, Chairman, Division of the Sciences, Colorado State College.

(1) Does he recognize situations involving problems which need to be solved?

(2) Does he gather information relative to the problem from reliable sources?

(3) Does he use the facts he has collected in formulating an hypothesis?

(4) Does he select the most reasonable group of facts relative to the hypothesis?

(5) Does he organize and coordinate information and discover relationships?

(6) Does he synthesize data in reaching conclusions?

Problem solving activities for the purpose of changing behavior in a particular direction become more functional when related to the qualities of educative experience. Such activities contribute effectively to the improvement of the individual, school, and society by assisting pupils to develop competence in solving problems reflectively.

PLAN A CONSERVATION CENTER

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IN the development of the true concepts of conservation it is the lack of rich, concrete experiences that deters understanding. In the past we have been content to verbalize about experiences and pass over a multitude of multi-sensory aids.

Children experience freedom to observe and experiment under conditions necessary for survival from early babyhood. First explorations introduce the child to light, food, moving air, water, cold, warmth and objects through his sensory aids of seeing, tasting, feeling, hearing, and smelling. They learn to care for pets and experiment with mechanical toys. They know that changing seasons bring a change in the weather conditions. How often have we heard these observations from children:

"Some of the leaves in that pile that daddy keeps, are breaking into small pieces. Those leaves smell."

"My shovel is rusted."

"What happened to the water in the puddle?"

"The dog next door had puppies. Their mother has to take care of them."

Certain of these observations and concepts are common to all children. At this point we can help them acquire concepts and judgments adequate for intelligent thinking and acting. Children need some interpretations and explanations from adults in keeping with their ability, intelligence and maturity level. Research has shown however, that children learn from other children when they are exposed to an atmosphere conducive to experimentation and observation.

At an early school age it becomes necessary to plan a conservation center in order to give children the opportunity to gain understanding from first hand experiences. Heretofore, many misconcepts have been rationalized through the lack of adequate guidance. The tools, equipment, furniture, and apparatus that will become a part of the conservation center should be secured in the light of the major goals of conservation education:

To provide students with the knowledges, skills, abilities and attitudes so that they can intelligently exercise their democratic franchise as both citizens and voters of a free society.

To develop an emotional desire to participate in the solution of conservation problems.

To assume responsibility for their individual way of life whenever it involves the resources which commonly perpetuate our society.

In order to meet these ends the conservation program in the elementary school should provide the children with the opportunity to:

Observe and interpret the environment influencing their lives.

Practice and develop skills in identifying and stating conservation problems.

Interpret information obtained from related problems and questions.

Develop social and emotional responsibility from their inheritance of, participation in and contribution to the fundamentals of conservation understanding.

An elementary school that has the sincere desire to enrich its conservation education and provide these opportunities can always find an area suitable for a conservation center. Other reasons may exist to deter progress of such a center but no one has to excuse himself for lack of space. A medium sized storeroom may provide a convenient location for children to start their center. In lieu of this, a centrally located classroom might provide the storage space required for materials. The storage cabinets, chalkboards, bulletin boards, window benches and worktables can readily be made portable by adding casters to the legs of this equipment. Shelves can be added to old closets to provide storage space for heavier equipment and materials.

Ideally, each classroom should have its own conservation center. The only primary necessities for such a center within the classroom is sufficient shelf and storage space for equipment and supplies and several worktables for children to use in experimenting, testing, observing and displaying. Bulletin boards, chalkboards, gas outlets, running water, acid and alkali resistant top tables, and commercial aquariums and terrariums; although highly desirable are not an ultimate necessity. A fine program can be carried on with substitute materials and equipment.

Tools such as claw hammers, common pliers, files, glass cutters, hack saws, knives, portable vises, screw drivers, tin snips, wood saws and even shovels and trowels should be available in each center. These should be systematically stored in a suitable wall cabinet near the worktables.

In addition, such apparatus as bell jars, wide mouth bottles, bunsen burners, clamps, chemical thermometers, clinical thermometers, narrow flasks, extension cords, graduates, hand lenses, scrap metals, goldfish bowls, ringstands, medicine droppers, metal trays, microscopes, rubber stoppers, spring balances, test tubes, window screening, unglazed flower pots, unbleached muslin, and flower growing flats should also be made available for general use in each conservation center. Since this apparatus is nonconsumable and should last for a number of years with proper care, only the initial outlay of money needs to be considered.

To carry out conservation activities and experiences within the classroom or conservation center supplies such as stamp pads, candles, rubber tubing, glass tubing, modeling clays, panes of glass, binding wire, steel wool, plaster of paris, cardboard, terrariums, aquariums, cans, cigar boxes, pressed cardboard egg boxes, insect nets, fine meshed fish nets and display boards will be needed to initiate the program. At the end of the first year an inventory will indicate what replacements should be reordered.

There are several companies that offer kits of supplies and apparatus which are intended for use in a typical elementary school program. A list of materials included in these kits should be considered in terms of the areas of conservation. It is only reasonable to expect that these kits will not meet all the needs of soil, water, mineral, forest, wildlife and human conservation activities. Many materials can be brought from the home by the children. Dime stores, local industries, experimental stations, hardware stores and florist supply houses may provide supplemental equipment and supplies.

Throughout the planning for a conservation center, the teacher, administrator, consultant, and pupil should participate. Each group should discuss and record their needs. The person responsible for the ordering then has a compendium of suggestions that is representative of the needs of those who will have a part in the program. Those who have a part in the suggestions of materials needed, will have an interest in the assembling and using of them.

Efficiency of organization for storing materials will contribute to the usage of these materials. It should be noted however, that the organization of these materials in a conservation center should be kept simple. Complexity of a systematic scheme for storing these materials will tend to keep both teacher and pupil from making full use of such a learning situation.

Incidental items can be filed in small drawers. The drawers can be identified alphabetically through the use of tape or enameled lettering. If cupboards are used for storage they can be labeled; soil, minerals, water, wildlife, forest, human, and miscellaneous.

Materials such as objects, specimens and models which are informative through seeing or feeling can be appropriately arranged on display tables. Flat pictures, photographs, stereographs and stereo-viewers are best kept in filing cabinets. This provides an efficient way of indexing and storing materials for easy accessibility.

The teacher or consultant should assume the responsibility of the conservation center. The children too, should assume responsibilities for selecting materials, returning them properly, planning bulletin boards and displays. Learning how to take care of materials in itself is a conservation practice.

A conservation center is a fine place for teachers to get together and experiment for themselves. It will give them the kind of experience they need to gain confidence when working with children. This alone is an important reason for having a center. It is also a place to prepare and leave experiments for the next days lesson. It is for the children, a place where collections and items of interest can be mutually shared.

Your resources for teaching conservation are evident. Once they are centralized, they will be used much more than they have been in the past. There is no doubt that reading is essential to a conservation program, but allowing the children to explore and share experiences is going to make that reading more challenging.

COLLEGE COURSES IN ELEMENTARY-SCHOOL SCIENCE AND THEIR RELATION TO TEACHING PROBLEMS

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MANY student teachers and others in the field of elementary education have expressed in varying ways their dissatisfaction with the college preparation they have received for teaching elementary-school science. Although this dissatisfaction springs from a host of factors, one criticism seems to recur most often: "College science methods courses for teachers are generally of very limited functional value." The possibility that this and other criticisms are valid resulted in the initiation of a recent California study in this area. In this research, an attempt was made to identify many of the actual problems of California teachers in presenting elementary-school science to their pupils, and to determine the adequacy of contemporary college elementary science methods courses in meeting these problems.

PROCEDURE

A comprehensive review of the literature was made at the beginning of the study in order to extract published objectives of elementary-school science teaching and obtain a philosophical perspective relative to the nature and types of problems and viewpoints in this subject.

To secure a potential source for elementary science teaching problem submission, letters were sent to a representative sample of California elementary-school supervisors which explained the purpose of the study and requested their cooperation.

The fifty-two supervisors who replied were sent diary forms upon which they, and seven teachers they were to contact, were to record any teaching problems noted in a three-week period. In addition, supervisors were requested to record any major problems observed before the period. As a final check against problem omission, a prolonged search of the literature was made for further problems.

A check-list was assembled from the problems to determine their importance and the adequacy of their consideration in California elementary science courses. Of 500 check-lists sent to the original participating supervisors, (who each again contacted seven different teachers), eight additional supervisors secured through referrals, and elementary science instructors in twenty California colleges and universities, 161 usable check-lists were returned. The ratings of the three groups were then compared, and their recommendations for the improvement of elementary-school science courses analyzed.

The final step in the study procedure was to interview California teacher-training institution instructors of elementary-school science in regard to course offerings and requirements in this subject, to furnish a background of information upon which recommendations advanced through the study would be based.

EXCERPT OF FINDINGS

1. Contemporary objectives tend to stress a functional point of view, in terms of one's personal reactions to problems.

2. Objectives formed by "traditional" educational theorists tend to stress such criteria of selection for elementary science course content as adult utility and significance to a field of organized knowledge.

3. Objectives formed by "progressive" educational theorists tend to stress such criteria of selection for elementary science course content as interest, social welfare, and, child utility.

4. Much consideration in science objectives is now granted to concepts, principles, and generalizations, in contrast to a former purely factual and "nature study" approach.

5. The most frequently reported science teaching problems, in descending order, were those which involved: (a) materials and resources: (b) teacher skills, techniques, and security; (c) organization of instruction; (d) human relations, administration, and supervision; and (e) objectives and evaluation.

6. More problems related to materials and teacher skills were submitted by primary grade teachers than by intermediate grade teachers.

7. More problems related to the organization of instruction and objectives were contributed by intermediate grade teachers than by primary grade teachers.

8. Most of the problems relative to objectives and evaluation were gathered from the literature, and not from the reporting groups.

9. The number of problems reported diminished in rough proportion to basic training in elementary science, but increased with respondents who indicated a substantial background in science.

10. The majority of the problems was rated as important and inadequately handled in the teacher-training institution elementary science courses surveyed.

11. There were no significant differences in check-list ratings between California-trained teachers and non-California trained teachers.

12. There was close agreement between the teacher-supervisor group and the instructor group on problem importance.

13. There was little agreement between the teacher-supervisor group and the instructor group on the adequacy of handling of the problems in California college elementary science courses.

14. Eight California institutions required a course in elementary science for elementary education students; twelve did not.

15. Fifteen California institutions listed no science subject-matter prerequisites for

course enrollment; five insisted on prerequisites which ranged from six through twelve semester units.

16. Nine of the basic elementary science courses surveyed were taught with an integrated approach to content and method, seven emphasized method, and four were organized for content mastery.

17. The chief recommendations of teachers and supervisors in regard to course improvement stressed the desirability of concrete, practical, and non-technical course work.

18. The chief recommendations of college elementary science instructors for course improvement stressed more thorough science training through prerequisites, and mandatory elementary science courses for elementary education students.

19. Some of the statements of teachers, supervisors, and instructors for course improvement when compared were contradictory in their recommendations.

CONCLUSIONS

1. Although it is still possible to note a dichotomy in point of view, such "traditional" criteria of course content selection as human survival value, significance to a field of organized knowledge, and adult utility are either giving way to, or are being blended with such "progressive" criteria as interest, child utility, and, more slowly, social reconstruction.

2. Teachers are unaware of many problems in teaching elementary science, particularly in the area of teaching objectives and evaluation.

3. Most problems recognized by teachers relate to science materials and teaching techniques, regardless of whether or not they have taken a course in elementary science.

4. The number of science teaching problems felt by teachers tends to decrease with increased training in that subject, up to a certain point; training beyond that point seems to engender a greater evaluative ability, which elicits further problems.

5. Of the educators surveyed, the great majority was in substantial agreement that all but several of the teaching problems reported were important.

6. There is but little difference in the adequacy of handling of the check-list problems in elementary science courses conducted at the California and non-California teacher-training institutions surveyed.

7. Most of the check-list problems do not seem to be handled adequately in those teacher-training institutions surveyed, but their neglect cannot be attached to one cause. Stringent restrictions, often outside the instructors' control, relative to time, resources, students' previous training, and administrative concerns, tend to reduce the degree of consideration required to facilitate adequate handling of the problems. In addition, the solutions to the majority of the problems require competencies secured as the result of cumulative experiences in many facets of professional training in education. Finally, some confusion was manifested concerning the definition of "adequate." These factors must all be considered in the evaluation.

8. The majority of teachers sampled lacks the training required to fulfill the expectations aroused by contemporary elementary science objectives.

9. Most of the California teacher training institutions offer their courses on an elective basis, hence it is probable that many teachers will continue to omit these courses in their training.

10. Most of the California teacher training institutions offer their courses without enrollment prerequisites, so it is probable that many teachers will continue to lack sufficient science content backgrounds at the time of taking their methods courses in elementary science or after graduation.

11. Teachers and supervisors desire elementary science course to be of a non-technical, practical, and workshop nature, with a minimum of lecture and theory.

12. Contradictory recommendations for

course improvement from the educators sampled reflect divergent philosophical points of view as to the proper objectives of science in the elementary school.

13. Adequate preparation in teaching elementary science cannot be achieved in an isolated, single methods course.

RECOMMENDATIONS

1. A successful score on a science subject-matter competency examination, jointly constructed by the education and science departments, should be a prerequisite for enrollment in elementary science methods courses.

2. The methods course should ideally be taught by a faculty member who holds dual membership in the education and science departments, or an education department member who has a reasonably comprehensive background in science. In either case, the instructor should have had teaching experience on the elementary-school level.

3. The semester-unit value of elementary science courses should be increased, to provide for its increasingly important place in life and elementary education.

4. Elementary science courses should be functional in character, and should provide the students with enough manipulative skills and knowledge of basic science materials to enable them to initiate an activity program for any elementary grade level.

5. Elementary science courses should encompass grades kindergarten through six only, and should make careful provision not to neglect the lower grades in experimentation or other activities.

6. Science concepts and generalizations should often be analyzed in terms of how they would be taught at various achievement levels, and correlative activities, including experiments, explained and performed by the students.

7. Students should be urged to emphasize more strongly those activities which seem applicable to the grade levels they anticipate teaching.

8. Students enrolled in elementary science courses should be concurrently enrolled in practice teaching at campus laboratory or public schools, to enable them to put into practice, and concretely evaluate, ideas gained in the science methods courses.

9. College elementary science courses should be cooperatively, not individually, planned by several education or science education personnel, in terms of the elementary schools' function in a twelve-year interrelated science program.

THE TEACHER OF ELEMENTARY SCIENCE AND LISTENING

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Whatever disagreements there may be among teachers of science in the elementary school, there is agreement on the point that one of the most important aims of such teaching is to develop in the pupils a critical, reasoning, problem-solving set. This, in general, is also true of secondary school science teachers. There was a time when science was taught, especially at the secondary level, entirely for the sake of content. This view has been rather generally discarded. In stating the newer view Blough, for instance, says that one objective of elementary science teaching is to "help pupils to grow in ability to solve problems effectively." Craig says: "We can teach objective thinking about many natural and social phenomena." and that "We should not depend upon mere heresay and gossip; unwarranted prejudices against others should never be allowed to influence our actions."

One of the phases of life in a democracy most in need of the application by an intelli-

gent citizenry of such critical, reasoning, and problem-solving attitudes is the process of communication. All contact between persons involves this process. Never before in the history of mankind has there been such a variety of means of person-to-person and mass communication as exists today.

If we compare human communication in pre-literate days when all knowledge, tradition, and folklore were passed on by word of mouth and our present day communicative scheme of things we see a remarkable parallel. In both periods there is to be found an almost implicit faith in the efficacy and efficiency of the listening process. Today most of our social, political, recreational, religious, and educational communication is carried on at the aural level. Whether it be the morning conversation at the breakfast table, the evening television program, a meeting at the United Nations, or a sermon in church or synagogue, we find this unreasoning confidence in the effectiveness of this type of communication.

Strangely enough, we have been very much more concerned in our teaching with the less-used communicative skills. Reading and "Riting" have always been two respectable members of the three R's. Speaking has not been entirely neglected but the receptive portion of the oral communicative process, listening, has been almost entirely neglected. It has been assumed that this is some sort of a natural endowment of all humans. Such an assumption is, of course, completely unfounded for there are many skills involved in listening which are not provided for by any of the genes so far known.

It is a false assumption to suppose that listening is taught by the common admonition to "sit-up and pay attention" or by similar admonitions so often heard in classrooms. Listening is certainly not so much a function of the body or even of the ear as it is of the mind. Just as one can see without reading so one can hear without listening.

If we examine the process of effective listening we see that it involves the use of just those skills the development of which are mentioned by Blough and Craig as some of the most desirable outcomes of science instruction in the elementary school.

A good listener has a purpose, and even more important, is aware of that purpose. This purpose may be to be entertained, it may be to obtain ideas, it may be to get information, or it may be any one of many others. The kind of purpose governs the kind of listening that is done.

If one is listening to or for ideas, it becomes of the greatest importance to identify and follow the structural framework or outline of what is being listened to.

Effective listening assumes that the listener brings to bear all that he knows about the subject but also that he is able to distinguish that which he is listening to from that which he already knows or already believes. The poor listener has a tendency to hear only the echo of his own ideas.

One of the hallmarks of a good listener is that he is critical in the sense that he is evaluative. He weighs the logic used, is perceptive to the use of propaganda devices and is analytical in his evaluation. This implies that he is openminded and free from prejudices but not gullible.

It must always be remembered that listening is part of a two-way communicative process and that listening is therefore cooperative which implies attention and courtesy.

Above all else, the good listener must implement that which he has heard. He must alter or pursue his present course of conduct on the basis of the information received.

If one accepts the above thesis on the nature of an effective listening process it seems apparent that the responsibility for the preparation of good listeners cannot fall solely to the language arts portion of the curriculum. It is true that the social studies teacher has a great responsibility in this direction but no one is in a more powerful position to make a genuine contribution to

the kind of mind-set that will make a good listener than is the teacher of science.

It is true that at the elementary level the language arts teacher, the social studies teacher, and the science teacher are usually the same person. It is equally true that the trend toward integration has tended to eradicate sharp lines between subject matter fields. On the other hand, our psychological knowledge about transfer of training and the necessity of stressing common elements to secure such transfer makes it imperative that we consciously stress the communication skill of listening in our teaching of science as much if not more than we do in our teaching of the language arts.

It is in the belief that, in order to carry out this function the science teacher needs to know more about the teaching of listening, that the following brief summary of some of the things we know about the listening process, things we need to know, and ideas for the teaching of listening is presented.

Listening has been the most sadly neglected phase of the communication skills. Literally thousands of articles and reports of research have been produced in connection with the other principal receptive skill of communication, reading. These date back for more than half a century. On the other hand, the art of listening has only been subjected to examination by research to any considerable extent in the last decade and such research is still, unfortunately, at a very superficial level. Unhappily, also, most of such research has been done at the college level rather than at the elementary or secondary levels.

The limited amount of research on the nature of listening and on ways it may be taught has fairly well established the following propositions:

1. About 60 per cent of the elementary school day is spent in listening of one sort or another. This is far more than was estimated to be the case by elementary school teachers.

2. There are as yet no adequate instruments for the evaluation and measurement of listening ability but it is possible to arrive at satisfactory approximations of degrees of listening skills by using some reading tests at an oral level.

3. In the first four grades there seems to be a greater efficiency in listening than in reading; at the fifth and sixth grade levels there is no substantial difference between listening and reading skills; thereafter reading skills are more highly developed. The question, of course, arises whether this last fact is due to the stress laid on reading instruction in contrast to the lack of emphasis placed on the teaching of listening.

4. There is some relationship between reading and listening efficiency but only on the average; the poorest readers tend to be the best listeners. This is a reasonable finding when the dependence of the poor reader on listening is given consideration.

5. There is no ascertainable correlation between intelligence and listening skills. It seems, however, to be a fact that those of lower intelligence tend to depend more on listening than on reading.

6. While no one best technique for the teaching of listening has been developed, every available study shows that it *is* possible to increase listening efficiency by direct instruction.

There are three principal needs in the field of listening which must be met by future research:

1. An adequate test or set of tests to measure listening proficiency need to be developed.

2. Specifically validated ways of teaching listening need to be developed.

3. A responsibility for teaching this important communication skill needs to be inculcated among teachers of children.

The fact that such research is needed in no wise decreases the opportunity or the responsibility of the science teacher with respect to seizing every possible oppor-

tunity to sharpen the listening skills of his pupil. Some of the ways in which this may be done are as follows:

1. An emphasis on following oral directions accurately. Science experiments are ideally suited to this purpose. Directions should be given clearly and explicitly. The suggestion sometimes made that in order to improve listening ability the directions should not be repeated, does not appear to be well taken. Emphasis should, however, be placed on the desirablity and necessity for attempting to understand them on the first occasion on which they are given.

2. Science lessons are ideally suited to teaching proper techniques of note-taking. Such note-taking can be a very effective aid to efficient listeners when emphasis is placed on them as means of following the outline of what is being said.

3. The application of principles of scientific thinking to the analysis of radio and television speeches and discussion programs for the purpose of detecting propaganda devices and illogical non-sequiturs.

4. Practice in distinguishing that which one already knows from what is being said.

5. Practice in listening *for* ideas as well as *to* ideas.

6. Practice in listening to other pupils as well as to the teacher.

First and foremost among all methods of teaching better listening is that of teaching by example. Teachers are too often guilty of being inattentive and even disinterested when pupils are making their contributions.

It seems implicit in any discussion of teaching method that any one topic such as listening cannot be taught in isolation but only in an integrative combination with other skills. Certainly science teaching lends itself ideally to such an approach.

The teacher of science or the teacher teaching science at the pre-college level can certainly enrich his instruction by consideration of the connection between the objectives of such instruction and the art of skillful listening. Not only will the pupils' skill in using communicative processes be enhanced but they will also gain a better understanding of the practical applications of the scientific problem-solving attitude.

AN EARLY MOVEMENT TO PROMOTE FIELD STUDY IN THE PUBLIC SCHOOLS

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At the turn of the century, interest in nature study was developing to an unprecedented degree. Many teachers and many of those concerned with teacher education began to see the need for outdoor nature education in the public schools. In 1902, upon the death of Prof. Alpheus Hyatt, Curator of the Boston Society of Natural History, a fund was established to aid in making this possible in the Boston schools. By popular subscription money was collected for the "Alpheus Hyatt Memorial Fund for Field Lessons." The contributions were used exclusively to pay transportation costs of school children who could not afford to pay such fees. The fund served two purposes. First, it made possible for all children to take part in field studies which enlarged and vitalized their contacts with natural history. Secondly, it served as a nucleus to stimulate the teaching of nature study in public schools.

A report issued by the trustees at the end of the first year of operation of the fund

[1] Grateful acknowledgment is made to Mrs. Harriet Hyatt Mayor, daughter of Dr. Alpheus Hyatt, and to Mrs. Lelia Norwood Adams, Curator of the Annisquam Historical Society, for their assistance and encouragement in conducting this study. Thanks are also given to Dr. Harry A. Cunningham of Kent State University for a critical reading of the manuscript.

outlined its accomplishments and reported the enthusiasm which had been aroused. "Twenty-six teachers, representing nine schools, have had a share of the income. . . . The teachers have taken 2,308 children to the seashore and country. When the children could pay their fares they have done so, but the fare of about 1,000 children have been paid from the money provided." A total of 23 places were visited (beaches, hills, fields, ponds, Arnold Arboretum, Agassiz Museum, Public Gardens, etc.). One teacher wrote, "Lessons included spring and fall flowers, trees, geology, geography, seaweeds, marine animals, and birds." Another teacher wrote, "It has gone down in their school annals as one of the happiest days ever spent." The need and the problems involved in field study were clearly stated by one teacher who wrote, "Situated as our school is in the heart of the city, where even vacant lots are at a premium, field lessons are as necessary in the course of study as arithmetic. . . . The only trouble is lack of funds." In addition to the intrinsic value of nature study to the pupil, it was early discovered that such training was instrumental in promoting conservation—about which much attention has been directed in recent years. A teacher observed that, "The children who are trained by nature lessons do not thoughtlessly destroy life, either plant or animal."

The time was ripe to promote field study in the schools. It was indeed appropriate to organize the fund as a memorial to Prof. Hyatt who had done so much to advance nature education in addition to his career as an outstanding zoologist and paleontologist. In 1867 he, with his colleagues E. S. Morse, A. S. Packard, and F. W. Putnam, was instrumental in founding the Peabody Academy of Science which to this day, as the Peabody Museum of Salem, serves to educate the public in matters of natural history. From 1870 to his death in 1902 he was first custodian and then curator of the Boston Society of Natural History which now operates as the Boston Museum of Science. He organized the collections and exhibitions in an evolutionary sequence with a view toward public education rather than a jumbled assortment of curiosities. In 1870 Hyatt organized the Teachers' School of Science in which he often took part in teaching classes of biology to public school teachers of Boston. For over 30 years he continued in general charge of the school (Zirngiebel, 1899). Thirteen "Guides for Science Teaching," forerunners of our present-day work-books and laboratory manuals, were prepared between 1878 and 1896. Five of these he wrote himself. Among other authors was the son of his own eminent teacher, Louis Agassiz. It was said of Hyatt (Proceed. Boston Soc. Nat. Hist. 30:428. 1902) that, "He brought into his teaching much of the best that characterized Agassiz's methods of instruction." In 1880 Prof. Hyatt established the Annisquam Seaside Laboratory which trained teachers as well as investigators and later evolved into the Woods Hole Marine Biological Laboratory (Dexter, 1952). Shortly before his death the Boston Society organized for the first time field courses of instruction in botany and zoology. These were known as the "Lowell Free Courses." Two years earlier a field course in geology had been established (Proceed. Boston Soc. Nat. Hist. Annual meeting of May 7, 1902). A. G. Mayer (1911) wrote, "It is as a teacher of teachers that he will be best remembered by the public of Boston. He loved to teach, but was never a pedant, for as he said: 'teachers and scholars should recognize that science is infinite, and they should work as companions learning from each other's observations.'" Apart from his scientific researches and publications, his most significant contribution was the promotion of science education for teachers. It was most fitting, then, to continue his interest in outdoor nature study by means of the Memorial Fund for Field Lessons.

Over $5,000 was collected during the first year of the campaign for funds. Prof. Wil-

liam H. Niles was president of the trustees. Stephen H. Williams was the treasurer, and George W. Lee served as the secretary. Others who served as trustees and who worked to promote the fund included the following: E. S. Morse of the Peabody Academy of Science, A. S. Packard of Brown University, Mrs. Jennie Arms Sheldon, and Frances Zirngiebel. It was the latter, a Boston teacher and former pupil of Dr. Hyatt, who originated the idea for the creation of this fund. A theatre performance entitled *America—In Old Days and New* was organized and presented in the Bijou Theatre of Boston on December 3–5, 1903, for the benefit of the memorial fund. Episodes of American history were enacted by various civic groups. The text was prepared under the supervision of Edward Everett Hale. Also, an illustrated lecture by W. L. Underwood entitled "The Children of the Woods" was given at Association Hall on November 22nd to raise money for this fund.

A. Lawrence Lowell commented on it as follows: "Prof. Hyatt's work in teaching science, and especially in diffusing scientific knowledge among children, through their teachers, is one which this community ought to commemorate, and this method of doing so is certainly a most fitting one." The Rev. Edward Everett Hale wrote, "I cannot think of any plan for a memorial to our dear friend, Prof. Hyatt, which would have pleased him so much as this proposal for taking Boston children into the open air."

How long the fund and its work continued is obscure. It was in existence for at least a decade, but gradually slipped into oblivion. Those who promoted it met with some opposition just as Hyatt himself had met with opposition from those not in sympathy with nature and science education. Hyatt and his followers were ahead of their time. At least the work was appreciated by those who saw its value and could take advantage of it.

In later years youth camps took up the work of nature education. Summer schools and field stations have added materially to the training of teachers for field study. In recent years emphasis has been placed upon conservation education. In a half century, however, we have not yet reached a desirable situation in regard to nature and conservation education. Riddle et al. (1942) have shown in their studies the woeful lack of proper field and conservation studies in public schools and of adequate training for teachers in those areas. The importance of such activities with suggestions for teachers have been summarized by Adams (1942) and by the writer (Dexter 1943; 1951). A recent study of the teaching of biology in a large metropolitan city and its environs (Kunze, 1952) has demonstrated that much still remains to be done to provide adequate nature and conservation education in the public schools in spite of some important gains since the "Alpheus Hyatt Memorial Fund for Field Lessons" was established over 50 years ago.

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ELEMENTARY TEACHERS AND CONSERVATION EDUCATION

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DESTRUCTION of natural resources is a behavior pattern not peculiar to the past two centuries. However, relatively recent worldwide human population pressure and increased technological facility have greatly accelerated the process. In our own land, recognition of the hazards of resource exploitation was evidenced first by legislative and executive restrictions placed on the misuse of a particular resource within an isolated area. These restrictions were bitterly opposed by many individuals who resented any infringements upon the individual's "right" to use as he wished all the resources which he "possessed."

Conservation, it was discovered, depended basically on an aroused, intelligent public opinion. It became, therefore, a problem for education. Education has obviously been inept and ineffective in this respect. Schools, in the main, have shown an indifference to, or disregard for, opportunities for acquainting students with the basic facts and problems of the wise use of resources.

A recent report of the National Committee on Policies in Conservation Education [1] very clearly emphasized a fundamental premise by stating that teacher training is the critical factor in developing a program of conservation education since it is the teacher's own feeling about and understanding of the problems of resources and their utilization which largely determine the kind and quality of conservation teaching done. On the assumption that this premise is valid, the author's purpose in a recent investigation [2] was to compare the conservation attitudes possessed by elementary school teachers in training with those of specialists in conservation and to investigate the extent to which conservation information and other selected factors may be related to the possession of these attitudes. The data were obtained from an attitudes inventory, an information test, and a questionnaire,* all specially constructed and administered to 1626 respondents in selected state teacher training institutions of Missouri and Kansas.

A number of studies have been made of the general problem of conservation education; others of the measurement and alteration of social attitudes. A few investigations have dealt with the status of teachers with regard to the problems of conservation education. Only one, a recent doctoral investigation [3] at Iowa State College, was concerned directly with the beliefs, opinions, or attitudes of individuals toward the vital issues of conservation.

After an extensive survey of the literature on attitudes and attitudes measurement, the author reached some fundamental conclusions with regard to the measurement of conservation attitude patterns. Attitudes do not exist independently of behavior. Furthermore, the behavior exhibited by the person in a given situation is influenced by the complexity of the situation plus the many, sometimes contradictory, attitudes which impinge upon him at the moment of the behavior. In light of these conclusions and because of the limitations of the commonly used methods of attitude measurement, the investigator proposed to measure the conservation attitudes of his respondents by confronting them with specific, concrete situations involving problems of conservation and requesting them to agree or disagree to certain possible behavior reactions based on those situations. From their reactions, the general attitudes

* Copies of these forms may be secured from the author upon request.

toward that particular situation was to be inferred. The situations and their responses were scored by use of a key developed through the collaboration of 18 conservation specialists. The reactions of these specialists were sufficiently similar, usually above 90%, to be considered significantly indicative of the accepted reaction of those persons best conversant with the problems of conservation and, therefore, indicative of the preferable reactions of the average individual.

Such a procedure promised some advantages not held by other methods of attitude measurement. First, the behavior reactions could be considered without the limitations of direct observation. Secondly, although the responses required verbalization, the specificity of the situation and the offered response eliminated the necessity for generalization or abstraction by the respondent.

To measure the level of conservation information possessed by the respondents, an information test was prepared which was composed of 60 multiple choice questions covering the general field of conservation.

Both of the above measuring devices were subjected to preliminary administration and statistical techniques and were found to be sufficiently reliable for practical scientific purposes.

In order to obtain data concerning age, sex, total college hours completed, college science hours completed, years and location of teaching experience, childhood background, and club or camp experience of the respondents, a personal data questionnaire was prepared.

Subject to the limitations of the study and on the basis of the data secured with respect to the purposes of the investigation, certain conclusions seem to be reasonable with respect to elementary school teachers in training.

After consideration of college courses in conservation, botany, zoology, geology, and geography, as they are now organized and taught in the selected colleges, only the conservation courses appear to be signally effective in producing more conservation information or higher attitude agreement with conservation specialists. No significant differences were detected between those persons who had and those who did not have credit in the other courses.

Only those group organizations set up specifically for the purpose of giving information and influencing attitudes in conservation appear to affect significantly the conservation information and attitudes of the respondents. Other organizations which may incorporate incidental conservation training into their programs seem not to be effective agents.

The data indicate common factors operating to produce in the respondents more conservation information and higher attitude agreement with conservation specialists. Likewise, those factors which do not appear to influence the possession of conservation information, similarly do not appear to influence a close agreement with the specialists in behavior responses. Increased experience in teaching, up to about fifteen years; increased college semester hours, up to the graduate level; or more semester hours of any kind of science, up to about twenty hours, are factors which tend to increase conservation information and attitude agreement. On the other hand, the same factors, in excess of these maxima either do not influence additional significant gains or actually allow a decrease. Neither the sex of an individual, his childhood home, nor the location of his teaching experience seem to have any important relationship to his conservation information or attitudes. Although differences were discernible at times, they were not consistent or statistically significant.

Individuals seem inclined toward higher agreement with conservation specialists on general principles of conservation than on applications of the principles to specific resources. Situations which involve self-interest or emotional and superstitious elements tend to cause a lowering of agree-

ment with conservation specialists. The inability of an individual to make clear-cut decisions on conservation situations appears to be highly related to his lack of information of and/or insufficient experience in the situations.

In light of the findings, it seems reasonable to propose to those in any capacity who have the responsibility or opportunity to prepare, improve, or assist elementary school teachers, that certain modifications in the present situation would be desirable. All instructors who take part in the training of elementary school teachers, and especially those who teach courses in geography, geology, zoology, and botany, should revise the organizations and methods of their courses in order to utilize all available opportunities for providing information and experience in conservation which may be relevant to their particular purposes and objectives. Furthermore, cooperative planning by professional educators and conservationists should result in the establishment of conservation education as an integral part of all pre- and in-service teacher training curricula as well as in the general curricula of the public schools.

The data that indicate that a direct approach is more effective than an indirect approach in the development of conservation information and attitudes would lead us to propose that one or more courses in conservation education should be organized and taught in each teacher training institution. In addition, specific information, materials, and technical help should be provided by educational and conservation agencies to assist teachers in developing positive conservation curricula in all elementary schools. Furthermore, existing out-of-school group organizations which already have established contacts with large numbers of youth should place more directed emphasis on the various phases and over-all problems of conservation.

If it is valid to assume that wise use of our remaining resources is essential to America's continued welfare and place of importance in world affairs, that education is vital to an enlightened public attitude toward conservation, that teachers are the critical factor in developing a well-informed public, and that the results of this study are indicative of the training received by elementary school teachers, then the obligation resting on each teacher training institution is apparent with respect to an examination of its offered experiences in conservation education.

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PRESENT STATUS AND PROBLEMS OF ONE TYPE OF GRADE-PLACEMENT RESEARCH *

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This is a brief report of an attempt to discover whether pupils can learn to apply vicariously, in a written test situation, some basic principles of physical science which are helpful in classifying their local present environment. It also seeks to find out whether mental age and grade level are factors in this learning.

The research has involved more than

* Paper presented at the Thirtieth Annual Meeting of the National Association for Research in Science Teaching, Hotel Claridge, Atlantic City, New Jersey, February 16, 1957.

twenty studies; these are listed in the bibliography at the end of this paper. The research procedure involves pre-testing, showing of a multifaceted demonstration (on a single science principle) accompanied by a carefully worded oral exposition, and immediate post-testing with the same test which was used as a pre-test. A control group, which was one-half of each class, was selected randomly. They were given the pre-test and after a short play-period were given the same test again. Test reliability was calculated separately for each grade to which a test was given, using data from the control groups. Gains on the test, in the absence of instruction in the control group, were discovered. The method is fully described in Oxendine's dissertation.[1]

Definitions and assumptions.—For the purposes of this study, grade placement is defined, and some assumptions are made in the following statements:

1. *Science principles* are those of Wise, Martin, Robertson, and others. They are statements representing physical relationtionships among aspects of the environment. They are not facts, definitions, topics, or socio-economic interactions.

2. Learning has taken place when a pupil is able to use a principle to classify correctly phenomena of his own environment. Having learned, he can recognize that the observed phenomena are members of the same class as those from which he derived the principle in the teaching-learning process. He does not ever necessarily state the principle, in words. In general, except for sampling design in a test, he will classify correctly *every* common situation of his own environment which exemplifies this principle. The correct response will be made in the face of strong distractors seeking to divert him from his decision.

[1] Herbert G. Oxendine, "The Grade Placement of the Physical Science Principle 'Sound is Produced by Vibrating Matter' in Relation to Mental Age." Unpublished doctorate dissertation, Boston University, 1953.

3. There is a lowest grade level at which it is profitable, in terms of efficiency, to spend a reasonable amount of time in attempting to have pupils *understand* a physical science principle and learn to use it as a powerful tool for classifying phenomena of his current nearby environment. The level of efficiency was decided upon to be fifty per cent; that is, it is profitable to teach a principle at that lowest grade level where one-half or more of the experimental group could learn or understand a principle as evidenced by their ability to use it effectively in a test situation. Note that there is no denial of the fact that many, *but not all,* principles can have been partially understood and partially used by pupils long before they reach the grade level suggested as a result of this research.

4. Results are reported, in terms of achievement on the tests, in reference to mental ages. Teachers may compare classes or individuals in their own situation with pupils' performance on the tests of this research study.

It was known and demonstrated that the range of mental ages, in the northeast portion of the United States, was for any grade very large. The middle eighty per cent of the group (mental-age criterion) was considered to be the typical grade group. The upper ten per cent (mental-age criterion, also) and the lower ten per cent groups were reported separately.

5. The teaching of principles by this method is not a total nor a substitute method of teaching science. It does not monopolize the teaching time for science. It is one aspect of the intellectual growth and development of pupils. There is little danger that this type of teaching will be done too early. There is a real danger that it will be done too late or not at all. Those pupils who are highly endowed intellectually and who exhibit a strong and continuing interest in science might be expected to enjoy and to profit by the techniques used in this research.

LIMITATIONS OF THE METHOD

1. The demonstration, with its accompanying oral exposition, is a very complex segment of teaching to be done in a period of twenty minutes. It demands extreme concentration on the pupils' part. Even though the demonstration is of large size, it may penalize pupils at the back of the room. Yet it has dramatic appeal, is vigorous, and probably represents a better demonstration-exposition of a single principle than the average classroom teacher would have time and materials to produce.

2. Pupils are not allowed to ask questions, nor even allowed to speak. This must be a severe penalty to learning. Obviously, however, the research would be invalid without this condition.

3. The same test is used for both the pre-test and the post-test. Early research indicated that there was no need for an alternate form, nor even for the "scrambling" of the items nor of the position of the multiple choices in relation to the correct choice.

Gains made on the post-test over the pretest by the control group were used as penalties to reduce the post-test score of the experimental group. Gains were small, however, and resulted in all probability from the teaching power of the pre-test.

The tests have reasonable reliability. None is below .51, many range from .74–.83. The tests usually consist of not less than 17 nor more than 25 items; after a rigorous item-analysis technique has eliminated poor items, these reliabilities are near maximum. They may be a little high due to the fact that the consistency of response of pupils may be being measured to some extent, rather than the reliability of the test. Careful inspection of many tests does not seem to justify this conclusion, however. It might be suggested that the tests be made longer to increase their reliability. This is impossible. *Every* application of the principle to be found in the environment available to the pupil is the subject of an item. It is often impossible upon long trial by twenty science teachers to obtain even one more face-valid item to add to the twenty-five or thirty in a test. Changing the form or wording of an item would create a parallel test form and would not lengthen the test. These are homogeneous tests and are not subject to many of the rules of ordinary hetereogeneous tests or of a test battery.

4. The vocabulary of the tests was carefully chosen. Non-science words were checked with Thorndike or other accepted lists. Science words on the tests were those which were the subject of the exposition and the demonstration, and so became part of the total picture of learning and testing.

5. Most studies bracketed their research at two grade levels, as four and six, or five and seven. Grade levels are indicated in the list of studies in the accompanying bibliography. Pilot studies helped to set these levels. There were some inconclusive results because of poor judgment here. It is relatively easy, however, to replicate most studies at grade levels other (usually higher, so as not to have vocabulary problems) than those for which the study was originally planned. The demonstration, the test, and a tape recording of the oral exposition are preserved.

6. The numbers of pupils tested are still too small for exact conclusions to be stated. Most studies were conducted in five different schools, two grades in each school. Total numbers in each study ranged from 175 to 250, except for Oxendine's study, which involved 700 pupils in 15 schools scattered over New England and North Carolina.

CONCLUSIONS

1. Intelligence is, of course, a factor in the distribution of scores on the short homogeneous tests. From graphic and tabular indications, scores on these tests are closely predicted by mental ages (Otis Quick-Scoring). Few correlations have been run

because of the lack of sufficient cases in many of the studies.

2. Without minimizing the importance of other factors, grade level can be said to be important indeed. Again and again, the scores on the pre-test were significantly higher (at the five per cent level) for the upper of two grades tested. After teaching, both grades were seen to move upwards, except in cases where the principle proved much too difficult for either grade (see Parkes). Sometimes the lower grade would reach as high as did the upper. Sometimes the relative gap between the two grades as established by the pre-test would be maintained without any significant change.

All of these occurrences are concerned with maturation. One aspect of maturation is the opportunity which it affords for pupils to adventure more widely in their environment. In two years, for instance, pupils may have had a few more *noticed* experiences; their membership in a *class* of experiences is not recognized. They are latent. When formal teaching presents the demonstration-exposition, these experiences are seen to be part of a hitherto faint pattern. The latent experience is developed, as it were, by the strong, direct, and precise thought process as a single principle is taught.

The test-design here plays an important role. Intelligence and interest are also factors. Nevertheless, maturation seems to be established as a major factor.

3. *It is predicted that many of these basic science principles will be found to be capable of being learned by a substantial part of classes at lower grade levels than have traditionally been exposed to either the principle or the method. Certainly, grades 7, 8 and 9 should be fertile fields for classroom experiments with the methods of teaching principles as tools for understanding the environment. Implications for a revision of the aims of junior high school science are many. Able pupils in upper elementary grades can share in the study of formal science.*

Several studies found that the principle was much too difficult for the grades chosen. Parkes, for instance, found that the principle, "Whenever an opaque object intercepts rays of radiant energy, a shadow is cast behind it," was too difficult as presented by his demonstration for either grades six or eight. This seems incredible when it is common knowledge that small children experiment with their own shadows; but note that this principle also requires that X-rays, infra-red rays, and gamma radiation, among others, must also be brought into the real understanding of this principle. There is a difference between the naive observation of a child and a real ability to see a new and unfamiliar situation as an example of a principle which "explains" a large class or set of phenomena.

NEXT STEPS

1. Replication of the various studies is continuing. Materials made available by the researchers become good teaching materials. Formal short-time presentation gives way to days or weeks of study on a principle, using the demonstration as a starting point. The class does research, meets in groups, reports to the class. They find new applications in their environment, may add items to the test. (The "heart" of the test, however, can still be used with its carefully evaluated items to gather data.)

In one study (among others still investigating other principles and new techniques), six weeks of carefully controlled teaching of aspects of *sound* and *light* were climaxed by retesting with two new and unique tests. This was "saturation teaching" of two groups of principles.

Independently, one large eastern city has embarked on an experiment in which 50 physical science principles taught largely by demonstration will be the sole subject of the science teaching in grade seven.

2. Individual studies of very able young

people, who have shown a continuing interest in science, are being made every year. Their response to the kind of teaching about single principles, which has been here outlined, is exciting.

The admittedly narrow and rigorous technique which has been described in this paper may well be a tool to improve the teaching of science principles. If this necessary portion of science education can be made more efficient, it may make more time available, at all grade levels including the upper elementary-school grades to young people to adventure in other areas of science. Some of these concern the transactions between science and society; the relationships of science and esthetics; and the greatest adventure of all—discovery.

THESES AND DISSERTATION SCHOOL OF EDUCATION, BOSTON UNIVERSITY

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Boston University School of Education, entitled

The Grade Placement of the Physical Science Principle

"Sound is Produced by Vibrating Material"
In Relation to Mental Ages

Purpose of the Study—The grade placement of scientific principles is an important aspect of teaching science at the elementary level. Heretofore, there has been very little experimental research done in this area. The investigator using a classroom demonstration technique took the principle, "sound is produced by vibrating material," and endeavored to discover at which grade level in relation to mental age the teacher may expect to get maximum learning, if the technique as is described in the following chapters of this study is used.

Scope—This study included fifteen elementary schools in New England. Five schools were selected in each of three areas, urban, urban fringe, and rural. This constituted a stratified sample based on the environment of the New England area. Seven hundred pupils from grades four and six were used in this study.

Procedure—Pupils were pre-tested to establish their initial knowledge of the principle, "sound is produced by vibrating material." The pupils were then randomly separated into two groups, experimental and control. The experimental group was given a lecture-demonstration on the principle, "sound is produced by vibrating material." The control group in another room was given a silent reading period. Both groups were given the same post-test. The post-test was the same as the pre-test, except that the responses to the items were arranged differently (scrambled) in the two tests. . . .

The pupils of the control group were, later, after taking the post-test, supplied with a written exposition on "sound is produced by vibrating material." This procedure was to show if such an exposition could be used to create interest to the extent that the pupil would investigate the principle, "sound is produced by vibrating material," on his own initiative. After a period of from three to four weeks the post-test (called retest hereafter) was given again. This was done to measure retention with the experimental group and to see if the exposition on "sound is produced by vibrating material" would create an interest with the control group. Finally, if both groups investigated the principle, "sound is produced by vibrating material," to such an extent that there was a significant difference in their scores on the retest over the scores on the pre-test, this retest study might evaluate the efficiency of another technique of teaching.

It was assumed that the time spent in a good demonstration with a carefully prepared lecture would result in a small increment of learning. . . .

RESEARCH PROCEDURE

After having secured permission from the school superintendents to do research in their schools, the investigator telephoned each principal and arranged a convenient date to visit his school.

Classroom technique—Upon arrival at the school the principal introduced the investigator to the fourth and sixth grade teachers. These teachers were briefed on how they might assist in the testing procedure. They were asked to work with their own classes. The investigator felt that this was necessary in order to eliminate any influencing factor that might originate out of the pupils' receiving instructions from someone strange to them.

The investigator talked to the fourth

grade for a short while to establish rapport. The test was explained as a game. The pupils were asked if they would assist the investigator with the study. In all cases the pupils were very cooperative. The fourth-grade pupils then took the pre-test (15 minutes). The investigator felt that the procedure would be accelerated if the fourth-grade pupils were started on the pre-test first, due to their slower rate of reading.

The investigator went to the sixth grade room and was introduced by the teacher to the pupils. After a short talk to establish rapport, the sixth-grade pupils took the same pre-test.

After the fourth grade pupils had completed the test, they were separated randomly into two equal groups. . . .

The sixth-grade pupils were separated into two groups (randomly). The sixth-grade control group went to the fourth-grade room. The fourth-grade experimental group went to the sixth-grade room. The experimental group was therefore in the sixth-grade room. The control group was therefore in the fourth-grade room.

It was necessary to keep to a minimum all external factors that might influence the outcome of the experiment. Therefore, all demonstration equipment, up to this stage of the procedure, was kept out of sight of the pupils.

The control group was given some graded (primary and intermediate) science booklets.[2] These booklets had been strictly censored for anything related to sound. The pupils were told that they might read the booklets.

The investigator then set up the demonstration equipment in the sixth-grade room, and gave a lecture-demonstration on the principle, "sound is produced by vibrating material." The demonstration will be explained in detail later in this chapter.

At the conclusion of the lecture-demonstration, the experimental group took the post-test. The control group took the same post-test at the same time in the fourth-grade room. The post-test was the same as the pre-test with the responses to each item scrambled.

For the purpose of collecting data for the study the experiment was completed at this stage. However, it was felt that the control group should be given a demonstration of some type, so as to prevent the feeling that they had been neglected. The control group was given a lecture-demonstration on the expansion and contraction of solids.

The control group was given a written exposition on "sound is produced by vibrating materials." They were permitted to keep these. The investigator felt that this exposition might serve as a motivating device to create an interest in "sound is produced by vibrating material" to the extent that the pupils might further investigate this principle on their own initiative. . . .

The Otis test[3]—Copies of the Otis-Quick-Scoring Mental Ability Test (Beta form A) were left with the teacher to be administered the day following the lecture-demonstration. The test papers were mailed to the investigator. This test was necessary in order to get up-to-date intelligence quotients and mental ages for each pupil.

The retest—Copies of the post-test were left with the teacher. Instructions were given to the teacher to administer these post-tests three to four weeks from the date of the lecture-demonstration. The tests were given and the papers mailed to the investigator. The data from this retest were used to measure retention in the experimental group. The data might also determine if the exposition on "sound is produced by vibrating material" stimulated any individual research on the part of the pupils of the control group. . . .

[2] Bertha Morris Parker, *The Basic Science Education Series* (Unitext), Row, Peterson and Company, Evanston, Illinois, 1948.

[3] Arthur S. Otis, "Otis-Quick-Scoring Mental Ability Test," World Book Co., Yonkers-on-Hudson, New York.

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER STUDY

The problem—The problem in this study is not a problem of teaching but rather a problem of discovering the learnability of the physical science principle, "sound is produced by vibrating material," by the pupils of grades four and six. The amount of teaching possible by the lecture-demonstration or by any other method in a 15 minute period is limited. The technique and procedure that the investigator used in this study were not designed to teach thoroughly the principle, "sound is produced by vibrating material." It was designed to discover at which grade level this principle might be introduced into the curriculum to attain maximum learning. . . .

Educational validity—Is the principle, "sound is produced by vibrating material," important enough to be placed in the curriculum? Is it necessary for an individual to know the principle, "sound is produced by vibrating material," and be able to apply it in order to adapt himself to his environment? If this is true it should be placed in the curriculum. Educational validity is based purely on logic. Robertson [4] and Leonelli [5] placed the principle, "sound is produced by vibrating material," in the elementary school curriculum. They based their findings on the opinions of leaders in the field of science and able classroom teachers.

Reliability—The coefficient of reliability of the test used in this study is .77. This is based on the average reliability derived from the Kuder-Richardson formula and the Pearson product-moment correlation.

Item difficulty—The average difficulty of the items on the pre-test at the fourth-grade level was .42 and at the sixth-grade level was .51. This indicated that the items were more difficult at the fourth grade than at the sixth grade. The average difficulty of the items on the post-test for the fourth grade was .49, and for the sixth grade was .60. The difficulty index approaches 1.00 as the test becomes easier.

Experimental and control group (pre-test)—There is no significant difference between the experimental and control groups on the pre-test in either grade, based on the principle, "sound is produced by vibrating material." The basic assumption then, is that the response of the experimental group to the learning situation was similar to that of the control group.

Mental age placement of the principle, "sound is produced by vibrating material"—This is the most important phase next to grade placement in this study. It indicates at which mental age level the pupils have developed to the extent that they are ready for this instrutcion. Table 10 clearly indicates that the mental age level of 11–12 is that point where the pupils indicate mastery of the text. This includes 37 per cent of the total population of the experimental group. Forty-five per cent of this group indicate that they have some knowledge of the test but not to the point of mastery. . . .

Grade placement of the principle, "sound is produced by vibrating material"—This is the most important phase of this study. The investigator has endeavored, by the preceding statistics, to present the analysis of data in such a manner as to clearly indicate where the principle, "sound is produced by vibrating material," might be introduced into the elementary school curriculum for best results. The achievement from the pre-test to the post-test for the fourth grade indicated that the pupils of the fourth grade were not ready for this instruction; this is, to the extent that the teacher might expect maximum learning of the material.

It is possible that the urban fringe population of the fifth grade with a well developed differentiated unit on "sound is produced by vibrating material," properly

[4] Martin L. Robertson, "Selection of Science Principles Suitable as Goals of Instruction in the Elementary School," *Science Education* (April, 1935), 19:65–70.

[5] R. E. Leonelli, *op. cit.*

taught, might achieve success. The percent mastering the test of the fourth-grade urban fringe area was 37 percent. It is assumed that with another year of experience, and with the educative growth of an additional year, this 37 percent might be raised to a 50 percent score, which would indicate that the principle could be placed at that grade level.

Richardson [6] and Guilford [7] place an item at the grade level where fifty percent of the pupils pass the item. The percent achieving mastery at the sixth grade for the total population was 57. Therefore the investigator feels that the pupils of the sixth grade area are ready for the principle, "sound is produced by vibrating material."

[6] M. W. Richardson, "The Logic of Age Scales," *Educational Psychological Measurement*, 1941, pp. 1–26.

[7] J. P. Guilford, *"Psychometric Methods,"* McGraw-Hill Book Company, New York, 1936, p. 409.

THE ACQUISITION OF CONCEPTS OF LIGHT AND SOUND IN THE INTERMEDIATE GRADES *

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THIS paper is based on a study done during the years 1955 and 1956 with both some new research and a doctorate as aims. There were, of course, other reasons for this particular study. In fact, the abstract of the dissertation concisely states seven purposes: (1) to investigate how children in the intermediate grades of the elementary school learn science concepts and principles in the areas of Light and Sound, before and after a planned teaching program in those areas; (2) to investigate the level of understanding of the concepts and principles before and after instruction; (3) to determine by means of certain instruments whether socio-economic background and intelligence are related to these understandings; (4) to discover if the performance on the various tests is a function of sex differences; (5) to determine if the amount of improvement in performance for the four tests is a function of the grade of the pupil; (6) to discover if there are interrelationships among the different tests following instruction; and (7) to determine which science principles regarding Light and Sound thought suitable for elementary science are understood by the children before and after instruction.

Procedure. One hundred and eighteen children from three different schools, representing members of grades four, five, and six were given the following tests before and after instruction in the areas of Light and Sound.

(1) *The Otis Quick Scoring Mental Ability Test, Beta, Form A.*

(2) *The Oxendine Sound Test.* This test was constructed by Herbert Oxendine as part of his doctoral dissertation at Boston University in 1953.

(3) *A Multiple Choice Word Classification Test.* This was constructed by the investigator and consisted of 77 words relative to the study of Light and Sound. The words were taken from the seven basic elementary science textbooks-series plus words from Junior High science texts through science physics texts. The Francis Curtis Criteria which define true science vocabulary were used on these words. To determine reliability of the test, it was administered to 150 boys and girls in the schools of Greater Boston—in the inter-

* Paper presented at the Joint National Council for Elementary Science—National Association for Research in Science Teaching Meeting Hotel Sherman, Chicago, Illinois, February 22, 1958.

m[illegible]des. This procedure served two b[illegible]poses. The first was that it gave [illegible]inary indication of the reliability [illegible] the test scores. Both the odd-even and test-retest methods of testing reliability were employed. The first technique gave some indication of the internal consistency of the test—a measure of the equivalence of the two halves of the same test. Since this measure is, basically, a measure of the reliability of half of the test, the Spearman-Brown Prophecy Formula was used to estimate total test reliability. The test-retest technique gave some indication of the stability of the test scores—a measure of the dependability of the test scores over a period of time. The second purpose served by the preliminary test was to determine whether or not there were any significant practice effects. To test for this, the Means for Test One and Test Two were compared. None of the differences was significant, so the possibility of any practice effects was ruled out. For the group that received the test once, the combined grade reliability was .88; for the other group which received the same test twice, the combined grade scores gave a reliability of .95.

The pupils in this particular study were grouped for the various tests according to socio-economic status. From the same Means, and differences in Means of the two social groups, high and low, we may assume that there were no significant differences in improvement related to the general socio-economic status of the school. The same was true in regard to the relationship between the degree of *improvement* and the *grade* of the pupil which implied that this test may be used in any of the three grades which comprise the intermediate grades of the elementary school, and that neither socio-economic differences in schools nor grade level should interfere with growth in learning in these two science areas after a special training procedure.

(4) *The Object-Classification Tests in Light and Sound.* In both Object-Classification Tests the child was asked to make pairs of science models, and then tell the investigator why he placed the particular items together. A hierarchy of responses was established by cooperative analysis with Dr. Edward Rawson from the Massachusetts Institute of Technology. If the child gave a perfect response for his classification he was given a score of *two,* and if he evidenced some idea or partial concept for the proper analogue he received a score of *one.* Scores were kept on all responses in both interviews by use of the tape-recorder.

The investigator prepared the teachers of the children in the areas of Light and Sound during eight workshop periods. The teachers did all of the teaching in these two areas to the children. At no time did the investigator do any actual teaching. She instructed the teachers, administered all of the tests, and interviewed the children before and after the teaching periods. The teachers were given materials and instruction in experiments and experiences during their workshop, and then proceeded to teach Light and Sound to their children until they felt that there was a saturation period, and that any more teaching would be forced and unnatural.

It would be wise here to stop and consider the types of children that were involved in this study. They represented three schools. Children from Schools A and B were considered to have a superior socio-economic background. For this reason a school of lesser socio-economic environment was chosen for reasons of comparison. This was called School C. This study involved a workshop in the principles of Light and Sound given by the investigator to the teachers of three different schools. Usually a committee of three secondary teachers and supervisors attended the workshop meetings also, so that the elementary science program in Schools A and B could be oriented successfully with that of the junior high at a later time.

After the testing program had been

finished by the investigator, the children were interviewed individually before the teaching of Light and Sound. Questions about their pre-conceived ideas in Light and Sound were asked as well as questions about their sources of science information. This interview, the verbalization during the Object-Classification Tests and the Second Interview, which was after the teaching of Light and Sound was completed, were all tape-recorded, transcribed and analyzed by the investigator. This Second Interview was usually about eight or ten weeks later when the teacher felt that the children had completed the study of Light and Sound.

The individual interviews usually consumed about twenty minutes of time, although some children were more verbose than others, and there was no time limit on making the analogies or "partners" of the science models. Perhaps you would like to know the types of models used in both of the Object-Classification Tests. Those that were used in Sound were:

A tuning fork and a bell
Tonette and recorder
Horn and reed
Bat and dog whistle
Ear muffs and insulation
Toy telephone and stethoscope
Violin bow and carpenter's file
Sea shell and gallon jug

Those that were used in the area of Light were:

Translucent light bulb and waxed paper
Mirror and bicycle reflector
Microscope and telescope
Prism and paint set
Camera and eye model
Diver's goggles and cellophane wrapped package
Spectacles and hand lens

Although there were naturally many answers and ideas expressed, here are a few examples of the correct pairing answers.

Tonette and recorder (correct). "There is a column of air that is changed as you finger it and that makes the different tones." A near-correct response would be, "You have to blow air into them to get music."

Tuning fork and bell (correct). "Both have fixed pitch." "They both have only one note." A response which shows a partial concept in this instance and was given a scoring of ONE, would be: "They both have a bell-like sound,—or they make the same sort of sound."

The bat model and dog whistle. Here the children showed quite an interesting response. The correct answers would have to involve knowledge of radar and supersonics, and surprisingly enough many children showed this knowledge. A little later I shall indicate how many of the pupils were able to respond correctly to this particular item.

The prism and the paint set of water colors was a difficult item, yet there were children who immediately were able to make pairs of the two models because of their knowledge of white light and the colors that are in light.

A careful examination of the items in the Object-Classification Tests will reveal that the models are all within the experience of the child, and may be used as regular classroom science equipment by the teacher. The analogies, or pairing of models, may be used as a means of evaluation of science teaching in the areas of Light and Sound, as a stimulus to classroom discussion, or as subjects for individual verbalization and revealing of understandings in the two areas. The models may be used individually as well as in pairs for problem-solving situations, and for investigations into types of thinking. Many informative patterns can be discovered by the use of the Object-Classification Tests, and although the use of the tape-recorder facilitated this particular investigation, a long-hand answer sheet might be used by the teacher who wished to keep records of the individual's achievements. A study of individual scores would provide diagnostic information to the teacher on the child's science progress. Similar tests may be built by teachers or

other investigators to determine the formation of concepts in other science areas. A study parallel to this one with older or younger children might prove of interest in order to obtain a portrait of how the emphasis on the sources of science information changes with the age of the child.

In regard to science principles, there was no direct teaching by principle either by the investigator to the teachers in the workshop, or by the teachers to their pupils. Science principles considered suitable for elementary grade science instruction were considered first when the analysis of data was being undertaken. However, since the boys and girls of this study also mentioned the understanding of other principles not usually considered at the elementary science level, principles usually considered for secondary teaching were also used. It was also necessary for the investigator to keep a special report on additional concepts related to Light and Sound that were not satisfied by a principle. For example, the investigator kept accurate account of the number of times that high frequency was mentioned. There is not a definite principle quoted in this research that mentions that particular concept as suited for elementary school science teaching, but the significant finding was that about 27 per cent of the pupils understood the principle before any instruction had taken place, and there was a 40 per cent gain in correct concept after instruction.

From the results of this study we may make the following conclusions:

1. Instruction produced a significant increment in the understanding of principles related to *Light* and *Sound*. Certain secondary science principles supplemented those which have been considered adequate for the elementary school. In the area of *Light*, the gain in principle-understanding was 270 per cent; in *Sound*, the per cent of gain was 248 per cent.

2. In concept-gain, as revealed by verbalization during the Object-Classification Tests, the *Sound* concept-gain was 120 per cent; in *Light* the per cent of gain was 260 per cent.

3. The Sound Test showed a significant improvement directly related to the grade of the pupil.

4. Pupils from the relatively high social-status schools and pupils from the relatively low social-status school showed about the same amount of improvement.

5. Grade and social status were not related to the amount of improvement on the various tests, but they were directly related to the level of performance, both before and after instruction.

6. All tests are significantly related to one another and to intelligence.

7. Sex differences did not affect test-scores either before or after instruction.

8. There was a difference between the scores on the intelligence test between the two socio-economic groups, but the mean scores of both groups lie within the range of normality.

9. The pupils named ***books, people, television*** and ***school*** as important sources of their science information.

It would seem that the time has not arrived for an investigation to end all investigations of the development of children's concepts in elementary science. This investigation was another expedition into the general quest for how children acquire science concepts, the level of their understanding, and whether socio-economic background and intelligence are related to learning.

It is recognized that a study of this nature has decided limitations. Some of the more important ones might be listed as these: (1) The investigator did not, at any time, teach directly the pupils of this study. The teaching of Light and Sound, though controlled by the materials, experiments and experiences which the teachers received in the workshop, depended a great deal upon the individuality and personality of the teacher and his particular teaching methodology and philosophy. (2) Schools A and B, you recall, were private schools.

School C was a public school in a large city system of undeniable superior educational reputation. It is possible that the results of the study may have been different if the schools had all been private, —or public. (3) The responses of the pupils during the interviews were sometimes verbose, and although a verbatim transcription was typed for every pupil interviewed, some responses could not be classified under the headings of understanding of science concepts or principles, or even be considered as a type or level of concept. This was due to the free-response, non-directive type of questioning employed during the interviews. (4) In School B, Grade 6 was not considered a part of the elementary school, but rather the beginning of an Upper School which encompassed Junior and Senior High School. This may have affected the teaching employed, since the method of instruction changed rather abruptly into a more formalized pattern with the pupil's entrance into Grade 6. (5) An objective of this investigation you recall, was to analyze the spoken responses of the pupils during the two interviews and to analyze the classifications in the Object-Classification Tests. The oral responses were more spontaneous than those which might have been given on a written test. (6) The quality and quantity of response given to the Object-Classification Tests may have increased considerably if the interviews had been of a different nature, when follow-up questions could have been used. (7) Most of the data concerned too few children to lend themselves to critical statistical treatment. An N of 118 is a small population, yet the data yielded not only the conclusions drawn but posed many challenging problems. It is possible that studies like this have great value in uncovering the *need for further exact experiments in discovering how children learn science.* This is a definite need in this year of space travel and nuclear research, a need which is felt by those interested in science instruction and by educators in general. The impact of scientific progress as we know it today demands that children, and especially children in the elementary grades, receive sound teaching in both physical and biological science. If we are to produce a citizenry oriented to this scientific age, the teaching of both sciences must indeed begin in the kindergarten days of our schools.

This study has indicated that children do know something about scientific principles long before they are taught to them in the schools, and that this knowledge is not merely casual and observational. May I leave you with this thought, which is one outcome of my investigation: Are we doing enough and are we expecting enough of our children?

NUTS TO SPACE TRAVEL *

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More than twenty years ago, this author was teaching youngsters about space travel and predicting its achievement before the close of the century. Therefore, he should not be misunderstood when he now says, "NUTS TO SPACE TRAVEL."

There is nothing wrong with the idea of space travel, but as the "great schnozzola" says, "Everybody wants ta git in da act!"

It is troubling to see many teachers and administrators all over the land tumbling over each other to get science into the cur-

* Paper presented at the Joint National Council for Elementary Science—National Association for Research in Science Teaching Meeting, Hotel Sherman, Chicago, Illinois, February 22, 1958.

riculum and space travel into science with little or no thought about basic purposes or procedures. The motivation seems to be based on public pressure for science to compete with Russia and her sputniks. It has been said that dictatorship brings out the worst features of democracy when democracy tries to imitate the achievements of the tyrant. It therefore seems appropriate to suggest to our educators that the presence of rockets, satellites, and space travel in the curriculum may do more harm than good unless the purposes are clear and the implications understood.

Our schools seem quick to add things to the curriculum but they seldom drop anything. Too often, the result is a kind of educational stew instead of a banquet of nicely planned courses.

Where then do rockets, satellites, and space ships fit into the science curriculum? They are part of several categories. Most obviously they come into astronomy since this deals with the universe beyond the earth. But they also contribute to earth study, to living things, to understanding matter and energy, and to man's use of science.

Many teachers are planning units around rockets in which the children never see the relation to the larger science areas. Such units may be interesting, dramatic, and informative but they could achieve a larger purpose if they were developed within the framework of a basic science curriculum.

Let us remind ourselves that the purpose of science education in the elementary schools is the systematic development of skills, knowledge, and attitudes about our *earth*, the *universe, living things, matter and energy,* and *man's use of science.* There are definite relationships between current developments leading to space travel and each of these five basic areas of science education. Let us be sure we think them through as we plan units so that we can be interpreters as well as dispensers of facts.

First we might ask and seek answers for these questions. Why does man want to leave the earth in the first place? What is to be gained? Are present national and international laws sufficient to control human activity in space and on other worlds? Who owns space and the worlds within it? What are the philosophical implications of man's attempts at space travel in view of the microscopic physical size of man and his earth in the terrifying vastness of the universe? What motives are driving men toward space? Curiosity? Discovery? Exploration? Exploitation? Answers to these and similar questions can help to establish a framework of values for us as we plan our space units.

Then we need to ask ourselves such questions as: What contributions can rockets and satellites make toward a better understanding about our own *earth?* There are many fine reports on information gained by satellites in the International Geophysical Year program. Do teachers and children read and understand these?

What are the facts about time and distance in astronomical space which must be understood before astronautics becomes a reality? What does astronomy have to teach us about space travel? Do we know the relationships of the planets and other objects in the solar system among themselves and to the stellar systems beyond? Do we understand the general organization of the universe? Without a sound basis in *astronomy* space travel units may be of very limited value.

What about *living things*? What do we mean by life? What are the biological and physical conditions in space? What are the conditions on the moon? on the planets? What is needed for survival in space and on other worlds?

The area of *matter and energy* offers good questions, too. What can fly in space? How do rockets work? What about chemical fuels, atomic fuels, ion propulsion, photon propulsion? How does a satellite get into orbit and stay there? How long will it stay? What is required for complete

escape from earth's gravity? Space navigation? How do you get back? How does relativistic time work in space? Questions in this area can bring out scores of physical and chemical laws and principles as related to space travel.

The final area of *man's use of science* brings us back once more to the reason for all education—the good of humankind. In every school activity human values should form the core around which planning takes place. In a subject as vast as space, it is easy to unwittingly conclude that tiny man and his tiny earth are of small value on the cosmic scale. Let us remind ourselves however, that while our physical bodies are indeed insignificant every man can look out at the stars and with his mind take in the universe. The value of a man lies in his mind and soul, not in his physical body.

One final plea. . . . By all means teach about space travel but not because it happens to be current or because the youngsters are keen about it. Teach it as an integral part of a larger plan of science education. Otherwise, nuts to space travel!

AN APPRAISAL OF ELEMENTARY SCHOOL SCIENCE INSTRUCTION IN THE STATE OF ILLINOIS *

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THERE are several significant reasons for discussing the content of elementary science, although it is understood that content is basically material for thought in situations where the learner is confronted with a problem. When a child selects and uses certain content in solving problems, he is improving his understanding of the functional use of subject matter. The following discussion considers these aspects of science content: grade placement of content, methods used to determine areas for study, the context in which science has been placed in the total school curriculum, and the time allotment for teaching science. The statements and conclusions which follow are based upon a recent investigation by the writer in a critical appraisal of elementary science teaching in the State of Illinois.

GRADE PLACEMENT OF SCIENCE CONTENT

Examination of current literature and research gives little evidence of agreement as to grade placement of science topics. Various children's textbooks include numerous subject-matter areas for each grade; difference is in degree and extent of concentration rather than variation of topics. A part of the consideration to be made for grade placement of science experiences must rest in an understanding of the nature of children. The intellectual maturity of the children, interests of the group, individual differences: all these aspects must be considered in the making of plans for science learning.

The Illinois teachers, involved in the current investigation, were asked to check those areas which were used in drawing concepts and generalizations for science learning. The list was composed of forty topics in the biological and physical sciences. The results showed the areas under Zoology, Physiology, and Astronomy were most frequently used by the teachers.

This writer believes the following organization of topics a desirable one. All grade school faculty members at the first of the school year should set up a tentative number (i.e. nine) of broad areas or topics in science (i.e. plants, animals, weather, energy, seasons, etc.) which are inclusive of

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The paper is based on an investigation completed at Northwestern University, Evanston, Illinois, 1956, as partial fulfillment for the Ph.D. degree.

the total science learning they believe are important to children. Each level (primary, intermediate, and upper grades) will take all of these areas and divide them then according to grades. The kindergarten teacher will select three; the first grade teacher three others; and second grade teacher the last three. The intermediate grade teachers (3, 4, 5) will take the same nine and divide them into three groups. The upper grades (6, 7, 8) will do likewise. This arrangement provides for a logical sequence of all areas eliminating the possibility of omitting some area of science while the child is going through elementary school. It is in agreement with those who believe in the idea of cycle teaching, for the same science concept is considered at the primary, intermediate, and upper grade levels consecutively. This encourages the development of meanings for science principles and concepts for as learning progresses and experiences are broadened, understandings will enlarge.

METHODS USED TO DETERMINE AREAS FOR STUDY

The determination of the areas for study provides an excellent opportunity for the teacher to promote cooperative curricular planning with pupils and staff. A larger percentage of primary teachers stated that science topics are selected and developed by the teacher from a variety of textbooks and supplementary science materials. A greater percentage of intermediate and upper grade teachers state that a textbook selected by the teacher or administrator is used almost entirely for the sequence of science topics. Less than one-fourth of all teachers determined the areas for study by the situation described as follows—problems and areas for study are planned cooperatively by the pupils and teacher from a flexible sequence developed by the grade school staff. A group of science specialists, who were selected to judge a set of guiding principles used in the present study for appraising elementary science teaching, agree that this method of determining science content a highly desirable one.

CONTEXT OF SCIENCE IN THE CURRICULUM

Having determined the areas to be studied, the next consideration is to decide how this learning can be organized in the total elementary school curriculum. The Illinois teachers were asked to indicate which of the following contexts best described the science program in their classrooms.

1. Science topics are brought incidentally into the classroom activities rather than by special arrangement or planning.
   Many science educators believe that this context leads to a haphazard, accidental consideration of the areas of science learning. It encourages repetition and superficial study of a few or many concepts and principles. The implication in this context does not mean that in a cooperatively organized program topics should not be brought in incidentally, for there are numerous times during the year when the child or teacher feels a current interest or need for engaging in a learning area which is not part of the plan. The objection to this context is that the total program is incidental and lacks sequence and planning.
2. Separate, distinct periods are devoted to science each week during which a regular course of study is followed.
   This second context is found in schools where the total curriculum is based on the separate-subjects organization.
3. Science is correlated with other subjects; emphasis being given to scientific aspects of those subjects as they arise from the subject under consideration.
   The third curricular organization is an attempt to teach several subjects simultaneously in an effort to assist the pupils to understand unified concepts. It results in a little bit of many subjects

taught at one time and is only a slight improvement over the separate-subjects organization. The area receiving the greatest emphasis is frequently the topic the teacher is familiar with or interested in. This gives science a great handicap in the race for inclusion.

4. Science is considered an integral part of several broad fields of learning; is integrated or fused with one or more other areas of learning. This organization is sometimes called the experience curriculum, the child-centered curriculum, problem-solving curriculum, or the social-functions curriculum. By whatever title it is designated, it implies an organization around the needs of pupils, their normal activities, and their social adjustment to life. It advocates the continuous growth of the whole child, active participation by the learner, and less concern with the future than with the present problems of youth.

In the investigation of the science teaching in Illinois, the largest percentage of primary teachers say that science is considered an integral part of several broad fields of learning, that it is integrated and fused with one or more areas of learning. The largest percentage of intermediate and upper grade teachers stated that separate, distinct periods are devoted to science learning each week, during which periods a regular course of study in science is followed.

TIME ALLOTMENT FOR SCIENCE ACTIVITIES

What would be desirable time allotment per week for the teaching of science in the elementary school, if we are striving for a well-balanced curriculum? The writer is aware of the difficulty in answering this question when the curriculum is coordinated or integrated with other learnings. Nevertheless, it is possible to arrive at an approximate allotment which we believe should be devoted to learning activities in the science area. Fifteen selected principals, curriculum directors, and college teachers were asked to give their opinion concerning this question. The mean was 2.7 hours per week that should be devoted to science learning.

In response to the question of time allotment, the mean for the primary teachers was 1.9; for the intermediate teachers the mean was 2.1; and for the upper grade teachers it was 2.4 hours per week devoted to science experiences. This is lower than the standard established by the judges, especially when the difference in time is accumulated over the total school year.

From this study one may conclude that there is need for improvement in the elementary schools concerning the grade placement of content, methods used in selecting content, the context in which it is placed in the curriculum, and the amount of time set aside in the day's activities for learning in the area of science.

REPORT OF SYMPOSIUM I

Implications of Recent International Scientific Developments for Research in Elementary School Science Teaching

Chairman: Muriel Beuschlein
Speaker: John Sternig
Recorder: Lawrence Hubbell

Muriel Beuschlein welcomed the group to Symposium I and introduced the recorder and speaker. Mr. Sternig emphasized the following concepts in his presentation:

1. The basis for science education should be laid before the pupils leave the eighth grade.

2. The natural curiosity and interest of the pupils in the area of science make science teaching easier than the teaching of other subjects.

3. Many teachers have not even caught

up with the subject of aviation, let alone understanding the concepts of the space age of which we are now a part.

4. The "Columbus" of today is in our classroom now. (1992 is the 500th anniversary of 1492.)

5. We should be preparing our children in the classrooms mentally, emotionally, psychologically, and through practical applications for the age of which we are now a part.

6. The skeptic of the science program—and of science fiction—is now more cautious in his remarks.

7. We should offer a sharper look at our present science programs.

8. Both teachers and parents are obligated to survey the implications of this rocket and space age.

9. Children are perhaps more ready for this information than they ought to be in terms of their present attitudes. They do not have the necessary facts needed for proper interpretation.

10. One obligation of the teacher is to sift fact from fiction in the presentation of materials in the field of science.

11. Problems of the space age were then discussed. The problems involved these in the following areas:

- a. The gravational attraction of the Earth
- b. The Jupiter C
- c. Knowledge gained through the satellite program
- d. Space travel
- e. Return trips
- f. Space stations
- g. Speed of light
- h. The time paradox

12. Teachers and parents must become scholars; we must learn about developments in our present scientific age.

13. We can keep abreast through reading in our libraries "Space Travel Section"—also through reading current periodicals.

A question and answer period followed in which many interesting problems were brought up. The meeting was adjourned at 11:45 A.M.

LAWRENCE F. HUBBELL
Recorder of Symposium I

HOW RECENT INTERNATIONAL SCIENTIFIC DEVELOPMENTS AFFECT SCIENCE IN THE ELEMENTARY SCHOOL *

JUNE E. LEWIS
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WHETHER we can attribute our present situation in elementary science to Sputnik and Mutnik or whether the climate is opportune for this "big forward push" is a "moot question." My hunch is that the Russian Satellites may have precipitated it a few months earlier than it would have normally occurred. Evidences to support this hunch are rampant through New York State and the New England States as well. As a "New Yorker" this is *all* of the United States!

For the past three years there has been an ever-increasing crescendo of "a K-12 science program—a K to 12 science program." A similar urge has been heard for more than twenty years but it was never so wide-spread and so forceful. Such scientific developments, as nuclear energy, radar, jets, rockets, missiles, radio, and television and the psychological factors created by them are undoubtedly instrumental in this "state of urgency" in which we as science educators happily find ourselves.

* Paper presented at the Joint National Council for Elementary Science—National Association for Research in Science Teaching Meeting, Hotel Sherman, Chicago, Illinois, February 22, 1958.

What are the evidences that the forward push is upon us? As an elementary science consultant for a State University Teachers College I am finding it increasingly difficult to be in more than two places at a time! Both classroom teachers and administrators are asking for counsel in the reorganization of science and mathematics programs. Classroom teachers want more science content, more "know-how" in providing opportunities for children to have first-hand experiences in science.

Both local and state administrators and institutions of higher learning are integrating their efforts in order to provide for the needs of classroom teachers. Last summer, in the State of Vermont, the State Education Department set up regional, in-service, elementary science Workshops for college credit.

Local administrators are organizing continuing in-service programs, consisting of workshops for up-grading teachers and curricular revision. School districts are organizing science and mathematics committees composed of members of the school board, administrators, teachers, and prominent scientists in their community. I know of one community in which such a committee is meeting every Monday night to survey their school's needs.

In the Fall of 1958, science will be a mandated subject in Grades K-10 in New York State. The New York State Education Department is putting "teeth" in this requirement by its proposed up-grading program in the improvement of the teaching of science and mathematics. The Department, in cooperation with the School Districts and institutions of higher learning, will instigate this program in the Summer of 1958. It is expected that an appropriation of six-hundred-thousand dollars will be available for the support of this program. Part of the appropriation will be used for the operation of Regional Summer Institutes to be held in designated colleges. The remainder will be used to support in-service training programs sponsored by local school districts. Teachers attending the Summer Institutes will be subsidized by the State. Tuition will be paid for teachers attending the in-service training programs held in local districts during the school year.

In both types of up-grading programs, credit toward certification and salary increments will be granted. The courses offered in these programs are to be designed for the teachers being served. They will not be regularly prescribed courses in mathematics and physical sciences leading to a degree. Special mathematics courses will be offered for teachers of elementary, junior and senior high school. These courses will emphasize fundamentals and understandings essential for helping pupils develop mathematical concepts. Separate laboratory courses in the physical sciences, with emphasis on physical principles, will also be offered to teachers working with pupils on these three levels. The personnel needed for conducting these state supported programs will be drawn from the high schools, the colleges, and industry.

These are only some of the evidences that the "big forward push" in elementary science is on. As classroom teachers, you are in a key position to assist in the structuring of a vital, challenging, science program. The time is ripe! You will be called upon to help our schools extend the philosophy, in which you believe, into the secondary schools. You believe in individual differences and the necessary safeguards for their perpetuation. You believe in the need for the fullest development of the potential talents of all children. You believe in the importance of providing rich backgrounds of experiences, and the need for time to experiment, read, and contemplate. You believe in the innate curiosity possessed by all children and the need to cherish and nurture it. If we can just find the way and the means by which we can incorporate your philosophy into this K-12 science program, we will never need to fear the challenge of the Sputniks that are bound to come. This is the challenge that we as teachers must and shall meet!

PLANNING A PRESERVICE PROGRAM IN SCIENCE SUITABLE FOR ALL ELEMENTARY TEACHERS

WILLIAM ADAMS, JR. AND LORIN E. BIXLER
Muskingum College, New Concord, Ohio

It is of paramount importance that the elementary teacher understand how to capitalize upon the curiosity of the child while he has comparatively few distractions. If one waits until the child reaches the seventh or eighth grade before introducing him to the wonders of nature and of science, he has reached the age of puberty when the distractions are increased which bring out changes in behavior and tend to dull his curiosity.

The elementary teacher working with children in these first six years of their elementary school life must be thoroughly acquainted with the natural and the physical environment in which the child is living and growing. This need cannot be satisfied with the usual or traditional college science course.

The traditional program for the preparation of elementary teachers permits or forces the student in preparation to pursue courses which vary from principles of geography, biology, zoology, botany, chemistry, physics, astronomy, geology, earth science, health and almost anything in the college curriculum called science. Most of the time these teachers in preparation are in classes with premedical students, biology majors and physics and astronomy specialists in which the greatest emphasis is given to pure science and the subject matter therein. This is a travesty to good elementary school science preparation. It is not an exaggeration to state that this kind of practice is similar to giving a practicing physician or a lawyer a course in elementary education and sending him out to practice medicine or law.

The college science program for elementary teachers should be designed avowedly with the prospective elementary teacher in mind. This means that any course in a subject matter area should be well thought out with the student's purpose and interests in mind. It is scarcely possible to cover the areas within the environment of most children in less than sixteen to twenty-four hours of college work. But due to other needs of prospective elementary teachers, the certification requirements in most states are of such a nature as to preclude the possibility of a college requirement of sixteen or twenty-four hours in the area of science. There should be no attempt to meet the needs of elementary teachers through the medium of survey courses, but rather should these needs be met through integration of the physical and natural elements of the child's environment. Let us examine these elements.

In the natural environment the child sees insects; he becomes a collector of stones, he may have a small toad in his pocket or he may wonder why the wind blows so hard, the sky is so blue or the sun shines so brightly or why the grass is so green and even from whence he came. All of these questions have logical, scientific and plausible answers with which teachers should have a speaking acquaintance. When the child asks why the grass is green, the teacher should know that it is because it has green coloring matter called chlorophyll. She should not only know about the green coloring matter, but its functions and the relationship of its function to such matters as air and all living things. When the child says to the teacher, "Why does the wind blow so hard," the teacher should know that the unequal heat of the earth's atmosphere causes convection of currents on the earth's surface. She should also know how to set up demonstrations to show the principles involved. The science preparation of the prospective elementary teacher should be designed to supply these answers.

There are many ways in which one could discover what the interests of the elementary school child are, such as interest inventories, anecdotal records, diaries, case studies. It would probably be impossible to encompass all of the background of science in a two semester course of eight hours. The following is a suggested outline of a course which has in some measure met the purposes and needs of elementary teachers as indicated in the preceding discussion.

Introduction to Science for Elementary Teachers *

The course, *Introduction to Science* for Elementary Teachers, is a course in science dealing with the science an elementary teacher will have to know in order to adequately use the materials now found in the public schools.

To give the prospective teacher some idea of the community and natural resources which can be found in the local school area, the course is organized on a seasonal basis.

Pertinent materials are selected and built into a course of study, which consists of six definite units with a sprinkling of other areas of science interspersed. An outline of the course of study is given below.

Outline of Course of Study

First Semester

Unit I. Fifteen class recitations, five two-hour laboratory periods.

Classification of the Animal World.

I. Phylum Arthropods (The division of the animal kingdom which contains the millipedes, centipedes, spiders, ticks, mites, crayfish, and insects).
   - A. Outline for study of Arthropods from text.
     1. Characteristics
     2. Kinds of animals in each group.
     3. Body parts and their functions.
     4. Metamorphosis.
     5. Physical characteristics (external).
     6. Economic importance.
        - a. Harmful.
        - b. Beneficial.
     7. Control of animals.
   - B. Laboratory study of Arthropods.
     1. Field trips to collect and observe animals in their natural habitat.
     2. Laboratory identification and study of insects.
     3. Preparation of Rieker mounts from hose boxes, cotton batting and moth ball crystals.
     4. Sight recognition of insects.

Unit II. The Study of Trees and Flowers in the Fall of the Year (Interspersed with the field trips and laboratory work in the study of insects.)
- A. Laboratory work—Hand work with leaves.
  1. Making blue prints of leaves.
  2. Making ink prints.
  3. Making carbon prints.
  4. Preparation of herbarium specimens of trees.
- B. Identification of trees by use of analytical keys.
- C. Sight recognition of trees in the field and the laboratory.

Unit III. The Earth and the Universe. 15 recitations, 5 two-hour laboratory periods.
- A. The Sun.
  1. Characteristics.
  2. Distance away from the earth.
  3. Solar heat and light. Its influence on the earth.
  4. Seasons, their cause and effect.
  5. The sun as a star.
  6. Sun spots.
  7. Age of sun.
- B. Stars.
  1. Characteristics.
  2. Number, magnitude and age.
  3. Constellations.
- C. Solar system.
  1. The Earth's place in the solar system.
  2. Planets, their number and position.
  3. Planets and their relationship to the earth.
  4. Comets, their cause and their known status in the universe.
  5. Meteors, their cause. Superstitions and the scientific method to disprove them.
  6. The Earth's moon.
     - a. Size.
     - b. Cause of waxing and waning.
     - c. Tides and their causes.
     - d. Eclipses of sun and moon, and their causes.
- D. The Universe beyond the solar system.
  1. Galaxies.
  2. Light years.
  3. Theories as to the origin of the solar system.
     - a. La Place's Nebular Hypothesis.
     - b. The Planetesimal Hypothesis.
     - c. The Gaseous—Tidal Hypothesis.
     - d. Genesis 1:1–20.
     - e. Urey's Hypothesis.
  4. Laboratory work on the Earth and Universe.

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* This is an outline of the course now being offered at Muskingum College, New Concord, Ohio.

a. Field trip to see moon and visible planets.
b. Field trip to see constellations and stars.
c. Field trip to see sun spots.
d. Laboratory demonstrations, including spectroscopic analysis of elements.

Unit IV. Living Things. 15 recitations, 5 two-hour laboratory periods.

A. Protoplasm.
1. Life and Protoplasm.
2. Visible structures of living things: the cell and the organism; classification of organisms.
3. Matter and energy in living things.
4. Chemical composition of protoplasm.
5. Structure of protoplasm.
6. Chemical processes in the living organism; Metabolism.
7. Osmosis and diffusion. Exchanges between the cell and its environment.

B. Nutrition in Living Things.
1. Nutrition in the animal cell.
2. Nutrition of the green plant cell.
3. The food cycle; other modes of nutrition.
4. Internal anatomy of multicellular plants, and nutritive mechanism.
5. Nutritive mechanisms of multicellular animals.

C. Growth and cell division of cells.
1. Mitosis.
2. Meiosis.

D. Laboratories.
1. The microscope. How to use the microscope.
2. The nature of protoplasm.
3. A study of cells.
4. Diffusion and osmosis.
5. Key to animal kingdom. Animal classification.
6. Parts of Plants.
a. Roots, types, cross-section, root hairs.
b. Stems-excurrent, deliquiescent.
c. Herbaceous stems.
d. Study of a winter twig.
e. Leaf-descriptions.
f. The structure of a leaf.
g. Carbohydrate synthesis.
h. Tests for organic compounds in foods.

Second Semester

I. Introduction to Science for Elementary Teachers. Unit I. The Earth and Its Parts. 18 recitations, 6 two-hour labs.

Topic A. The Atmosphere.
1. Gases of the atmosphere.
2. Tests for the determination of the presence of the gases of the atmosphere.
3. The atmosphere and its extension above the earth.
4. Atmospheric pressure, its influence on living things.
5. How air pressure is measured.
6. The cause of air pressure.
7. The influence of altitude on living things.
8. Humidity and its influence on air pressure; living things.
9. Layers of the atmosphere.
10. Instruments and their uses in studying air, air pressure and humidity.
11. Laboratory Work.
a. Determination of air pressure.
b. Determination of humidity.
c. Determination of gases found in the atmosphere.
d. Examination and uses of instruments for the study of atmosphere.

Topic B. The Earth's Crust and the Three Types of Rocks.
1. Study of Minerals.
2. Crystallization.
3. Types of rocks found on the surface of the earth.
4. Characteristics, formation and uses of igneous, sedimentary and metamorphic rocks.
5. Age of earth through an examination of evidences found in the earth's crust.
6. Classification of sedimentary rocks.
7. Rock salt, coal, oil, gas, sulphur, iron, gypsum, asbestos as rocks and mineral resources.
8. Uses of rocks in building and other industries.
9. Ohio's mineral resources.
10. Isostasy, and theories of continent formation.
11. Forms of igneous rocks.
12. Laboratory Work.
a. Study and identification of minerals in the laboratory by use of Foundation Stone Key.
b. Field trips to see formations of rock and minerals.
c. Preparation of individual collections of minerals and rocks.
d. Examination of fluorescence of minerals and rocks.

Topic C. The Changing Surface of the Earth.
1. Water on the Surface of the Earth.
a. The Water table.
b. Water and its influence on where people live.
c. The influence of water on industry, and where industry is located.
d. The Oceans. Their influence on people and other living things; equalizer of climate?
e. Ocean drifts, currents, swells, abysses.
f. Materials found on ocean bottoms.
g. Swamps, rivers, streams, soil water-ground water, lakes.
h. Sub-surface water and its influence on the rocks and minerals in the earth's crust.
i. Laboratory Work.
1. Ecological survey of Ohio by use of road map and population density studies.

2. Field trips to see streams, swamps, springs, etc.

2. Forces which Raise and Lower the Land.
   a. Mountain-Making, Fold Mountains, Volcanic Mountains, Fault Mountains, Mountains left by erosion.
   b. Earthquakes.
   c. Volcanoes, Magma, Lavaflows, Volcano belts of earth.
   d. Geysers and Hot Springs.
   e. Erosion, by water, wind and ice.
   f. On deposits and concentration by water.
   g. Weathering, by expansion and contraction, chemical weathering.
   h. Soil, its formation, conservation and land use.
   i. Glaciers, their forms and deposits.
   j. Laboratory Work.
      1. Demonstrations of wind, water and ice erosion, including films.
      2. Field trips to see effects of erosion in formation of local land forms.
      3. Field trips to study vegetation serves to see their influence on erosion.
      4. Conservation field trip to see wise land use.

Unit II. Plant and Animal Life of the Local Community. 3 recitations, 1 two-hour laboratory.

Topic A. Plant Life (Woven into all other field trips).
1. Study of trees in summer foliage, by use of description keys and by sight recognition.
2. Study of flowering plants other than trees, using Keys and by sight recognition.
3. Laboratory Work
   a. Study of trees by Keying out specimens.
   b. Study of flowers by Keying out specimens.
   c. Preparation of herbarium specimens.

Topic B. Animal Life.
1. Study of reptiles, fishes, amphibians, birds through Keys and field markings.
2. Collection and preservation of animals in field and laboratory.

Unit III. How Man Uses Magnetism and Electricity. 6 recitations, 2 two-hour laboratories.

Topic A. Magnetism.
1. Kinds of magnets.
2. Early magnetism and its uses.
3. Induction, magnetic fields.
4. The earth as a magnet.
5. Why a magnet works.
6. Magnetism from electricity.
7. Uses of magnets and magnetism.

Topic B. Electricity.
1. Historical survey of electricity.
2. Electricity—What it is and how it can be generated.
3. Static electricity.
4. Current electricity.
5. Lightning.
6. Electricity from chemicals.
7. Generators, dynamos and magnetos.
8. Circuits, switches, resistance.
9. Uses of electricity. Lighting, telephone, telegraph, radio, television, heat, industrial uses.
10. Laboratory Work.
   a. Making a magnet.
   b. Demonstrations and uses of magnets.
   c. Magnetic fields.
   d. Induced magnetism.
   e. Experiments to show that the world is a large magnet.
   f. Why the earth is a magnet.
   g. The magnet as a compass.
   h. Electricity causes a magnetic field.
   i. Electricity from chemicals.
   j. Electricity from breaking the lines of magnetic force.
   k. Static electricity.
   l. Current electricity.
   m. Dry cells, circuits, switches.
   n. Chemical electricity.
   o. Fuses, short circuits.
   p. Uses of electromagnets.

Unit IV. Energy and Simple Machines. 6 recitations, 2 two-hour laboratories.

Topic A. Energy.
1. Energy throughout the universe.
   a. Earth, stars are in motion.
2. Particles of the universe attract one another.
3. Forms of energy.
   a. Heat and the thermometer.
   b. Heat energy.
   c. Mechanical energy.
   d. Sound energy.
   e. Energy of wind and falling water.
   f. Atomic energy.
   g. Chemical energy.
   h. Energy changes.
   j. Source of sun's energy.
4. Laboratory Work.
   a. Centrifugal force.
   b. Influence and effects of gravity.
   c. Galileo's experiment.
   d. Running water and energy.

Topic B. Simple Machines.
1. Energy and inertia.
2. Friction a hindrance and a help.
   a. Sliding friction.
   b. Rolling friction.
3. What machines have as their basic factors.
4. Simple machines.
   a. Incline plane.
   b. The screw.
   c. The wheel and axle.
   d. Pulleys.
   e. Levers.
5. Laboratory Work.
   a. Energy to start and stop objects.
   b. Inertia.
   c. Sliding and rolling friction.
   d. Friction and gravity.
   e. Friction develops heat.

f. Lubrication reduces friction.
g. Friction is useful.
h. Friction causes wear.
i. Uses of levers.
j. Uses of incline planes.
k. Uses of wheel and axle.
l. Uses of simple machines to form complex machines.
m. The electric motor.
n. The water turbine.
o. Lift and force pumps.
p. Steam at work.

Living Things—How They Reproduce and Change (Heredity). 9 recitations, 3 two-hour laboratories.

Topic A. Reproduction.
1. Living things reproduce in different ways.
   a. Cell division.
   b. Spores.
   c. Conjugation.
   d. Binary fission.
2. Asexual and sexual reproduction.
   a. In plants.
      (1) A typical flower as the reproductive organ of the plant.
   b. In animals.
      (1) Hermaphroditism.
      (2) Parthenogenesis.
      (3) Sexual reproduction.
         (a) Reductional division to produce eggs and sperm.
         (b) Mitosis to produce identical daughter cells.
3. Laboratory Work.
   a. Microscopic work to illustrate the types of reproduction, to see spores, conjugation, binary fission, sex cells, mitosis.
   b. A study of a typical flower.

Topic B. Heredity.
1. The Mechanism of heredity.
2. Methods of studying heredity.
3. Segregation.
4. Independent assortment.
5. Linkage.
6. Inheritance of sex.
7. Heredity in asexual reproduction.
8. Cytophasmic inheritance.
9. Phenotypic effects of the genes.
10. Heredity in man.
11. Twinning; fraternal and identical twins.
12. Variations and selections.
    a. Recombinations.
    b. Aberrations.
    c. Mutations.
13. Limitations of populations.
14. Struggle for existence.
15. Adaptations.
16. Origin of species.
17. Laboratory Work.
    a. Determination of crosses in fruit flies.
    b. Variations; study of flowers, seeds, fruits.
    c. Study of populations.

This is an arbitrary outline and should not be regarded as a panacea or cure all for the ills of the science program in the elementary school. Rather this is an attempt to remove the elementary science preparation for elementary teachers from the pre-medic, pre-engineering or other science training and to design a course to meet the needs of the prospective elementary teacher.

SOIL "CONDITIONER" EXPERIMENTS FOR A GEOGRAPHY OR SCIENCE CLASS

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OBJECTIVES

GENERAL. To interest students in the science of soil through practical problems.

Specific. 1. To test the effect of a soil conditioner such as "Krilium" on soil. 2. To evaluate advertising descriptions in the importance of soil conditioners, such as the following:

"Krilium, a fine dry powder, mixes easily with your soil. Clear, simple directions on package show you how deep to mix it in for the type of gardening you wish to do. In most cases treatment 3 to 6 inches deep gives best results. Easy-to-use Krilium assures you of lasting benefits, not just near the surface but where you want them . . . in the soil around your plant roots. Krilium keeps your soil fine, loose and porus; easy to break up and cultivate. Krilium prevents soil from packing down and crusting over. In short, Krilium makes soil 'Friendly' to your plants. Your plants quickly develop big healthy root clusters. They get more water and air. They can make better use of the fertilizer you add.

"One thorough treatment with Krilium gives you the kind of soil it used to take years to develop.

"Krilium is wonderful for establishing flower

beds and borders, building and repairing lawns, planting bulbs, shrubs and perennials and transplanting."[1]

CONCEPTS ASSUMED

It is assumed that the students have learned the following basic soil concepts: (1) Soil is composed of five ingredients.[2] (2) Soils vary in fertility because the ingredients vary in amounts, texture, and structure. (3) Proper amounts of water and air in the soil stimulate the growth of the micro-organisms—the presence of which in the right amounts is essential for optimum growing conditions. (4) A loose, porous soil structure not only favors the accumulation of soil water and adequate soil air circulation but permits shoots to move up and roots to move down easily and quickly. (5) A loose, friable, porous soil is one in which the soil particles are held together in crumb-like clusters or aggregates. (6) Nature furnishes binding materials that hold soil particles together. (7) Binding materials result from the decay of organic matter such as straw, manures, compost, sewage disposal sludge, etc. (8) Nature's binding materials, so essential to providing a friable soil, are destroyed by fire, wind and water erosion, mechanical cultivation and over cropping, leaching, etc. unless there is a sufficient return of vegetable and animal manures. (9) The return of materials to the soil to provide binding materials is expensive and time consuming. (10) Man has been attempting to discover some synthetic material or soil conditioner which will help form a friable soil.

ARTIFICIAL SOIL CONDITIONERS

Various soil conditioners and soil conditioners with soluble fertilizers have been placed on the market in recent years. The Spring and Summer, 1954 Catalogue of Sears, Roebuck and Co., offered materials of this type for sale under the following trade names: Loamium, Cross Country Chemical and Krilium. Any or all of these three conditioners may be used in the following experiments. Soil conditioners with other trade names can be found in the Montgomery Ward & Co. catalogues, other garden supply catalogues, and in stores carrying garden and yard supplies.

EXPERIMENTS

Secure 50 to 100 pounds of three types of local soil, namely (1) a clayey soil, (2) a sandy soil, and (3) a good garden soil all from surface positions. (Use only 0–4 inches from the surface). In each experiment use two identical samples of both types of soil and treat one sample of each type with a small amount of Krilium soil conditioner as prescribed in the advertisement and leave one untreated.

Experiment 1. To ascertain whether treated or untreated soils hold the most water.

Weigh out equal amounts of treated and untreated (naturally dry) clay, or sandy, and garden soils. Number consecutively six large flower pots. Fill the pots equally to a line within two inches of their rims with these samples. Weigh the six pots and their soils. Sprinkle all of them until the water stands on the surface to the rim. Observe the time required for water to soak into and/or run through the soil. Record these observations. Sprinkle soil at intervals of 24–48 hours for three or more times. Which samples now weigh the most? Is this additional weight water? (Read Experiment 3. It may be carried on concurrently. If so, observe texture, structure and degree of soil dampness at top of pots.)

Experiment 2. To find whether untreated or treated soil loses water more rapidly due to evaporation.

Using the same pots and soils as in Experiment 1, weigh the samples at regular intervals for two or three weeks, record

[1] Spring and Summer, 1954, Sears, Roebuck and Company catalogue (Chicago) 1205.

[2] These experiments should follow experiments on the five ingredients of soil. For example, refer to Thomas Frank Barton, "Teaching Soils in the Lower Grades," *Journal of Geography,* XLV (1946) 309–16.

the weights and compare the results. Which samples lose water more rapidly than others? List tentative conclusions of results for plant growth.

Experiment 3. To compare surface condition of the various soils to applications of surface water.

During Experiments 1 and 2, as the days go by carefully notice the character of the soil surfaces in the pots. Test with tooth pick from day to day. Which samples tend to bake and crack the most? Which remain friable? Characterize the surface condition of each pot.

Experiment 4. To compare cohesiveness of soil particles (slacking).

Take six glass beakers and put a few spoonfuls of each soil in the bottom of separate beakers. Sprinkle on water until the mounds are covered. What happens? In which soils is there the greatest disintegration of the visible soil aggregates or soil crumbs?

Experiment 5. To compare the ability of stems and roots from seeds to penetrate through the various types of solids.

Remove the soils from the pots and place in glass terrariums. Plant a few beans, marigolds and/or radish seeds in each type of soil. Sprinkle soil well. Watch results as stems come to surface and roots go down. Compare growth of plants over several weeks. Carefully dig up some of the marigold plants when they are 4 to 6 inches high. In which type of soil has the best root system developed? It may be necessary to wash the soil from the root systems to view them adequately. List tentative conclusions of results for plant growth.

General Evaluation: In light of your results evaluate the two general objectives for conducting the experiment. Which of the three types of soil tested showed the most improvement? Then, evaluate Krilium (or other artificial soil conditioners if used) as a commercial product for flower pots, sandboxes, hothouse boxes, seedbeds, small gardens and 160-acre farms with most of their land cultivated.

These indoor experiments should be followed by outdoor experiences if possible. Simple outdoor experimental plots may be located on school-owned properties such as forests, camps, gardens, farms, estates, sanctuaries and orchards.[3]

PLACE IN CURRICULUM

These experiments may be performed by pupils and students at any level beginning with the intermediate grades. Of course if presented in the intermediate grades, these experiments need not be repeated at the junior high school level. Activities of this type may be used to correlate geography, conservation, science and social studies.

[3] For example there were 1,352 school-owned forests in the United States in 1950.

SCIENCE EXPERIENCES IN THE ELEMENTARY SCHOOL

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It is generally agreed that the core of learning experiences in the elementary school includes social studies, language arts, and arithmetic. The elementary school years are regarded as a period for exploration and orientation. It is a time for general rather than specialized education.

Why have science experiences in the elementary school? Although science does not seem to be deemed important enough to be a part of the "core" of elementary school experiences, science has a part in the elementary school curriculum.

Science has been described as a branch of study which is concerned with observation and classification of facts related to the physical world, i.e., the study of our environment. It is the responsibility of science to help the child become acquainted with the world of things.

Since all human activity is now influenced by science, we, the teachers, parents, mili-

tary leaders, statesmen, and employers, are concerned about the science experiences found in the school. The purpose of the school is to offer and supplement the activities of the home, the church, and the community agencies in aiding boys and girls in their development toward becoming mature, effective citizens who are personally, socially, and economically competent. Science is an important field of human experience and, therefore, requires a place in the elementary school curriculum.

The method, materials, and people in the science field are important parts of the world today. The gap between the experimentation in the laboratory and technology has been reduced—six years between the discovery of nuclear fission and the explosion of the atomic bomb. Science is in our every day lives whether in the form of a clothes moth ruining a coat, flies invading the home, or the atom bomb. As in life, science in the school must be a part of the total experience of the children.

Science is real to each of us. It is found concretely in our lives. Science teaching in the elementary school does not have as its purpose the development of scientists. But boys and girls do need to know how to use their environment intelligently. Science is intimately involved in living in modern society.

What are the objectives for learning science? Objectives for science teaching are necessary. Before teachers begin planning for science experiences for children, it is desirable, in fact, essential, to realize the purpose of the activities. The objectives should include:

1. Habits and skills, such as the habit of reading accurately and critically.

2. Knowledges and understandings, such as knowledge of the structure and function of the human body and understanding of the conservation of natural resources.

3. Attitudes, interests, and appreciations, such as open mindedness, suspended judgment, contribution of scientists, beauty in nature.

How should science experience be planned? The time at which science problems should be attacked is obvious—all the time, i.e., every year in the life of the individual. It will usually be the result of coincidence for the pre-nursery child—observation of rain, snow, sun; feeling hot or cold; and having pets in the home. However, from the nursery school upward there must be definite planning for science experiences. If a school has a twelve year program, grades 1–12, then the science program should be a twelve year program.

There has been a change from the systematic to functional approach in the organization of science experiences. Science activities may be a part of a science topic or problem—How can we predict weather– They may be correlated with another area—How have means of communication changed? They may be fused with another area—What does atomic energy mean to us? Incidentally learned science may come in a hobby period or in the assorted material brought daily to school, such as pets or leaves.

Science activities must take into consideration the needs and interests of the children. The children are interested in things that move, in the mysterious, and in activities in which they have a part. They are curious about plants and animals.

The teacher's role is that of helping the children solve their problems—ones that are real to them. Problems are found in areas of conservation, recreation, safety, and health. Various activities are desirable. These include experimenting, reading, observing, drawing, excursions, collecting, constructing. These must be selected with regard to the objectives that are stated. The teacher must plan a science program in the schools which:

1. Includes all phases of the environment.
2. Leads from the known to the unknown.
3. Is challenging.
4. Emphasizes problems which are real to the children.
5. Is non technical.
6. Is developmental.

How is science learning tested? Children need experience in thinking for themselves, using initiative, in carrying over into daily life principles learned in the classroom, and in evaluating their own activities. The teacher must check her own plans so that the problems are not too broad, contain too few actual experiences, use too few community resources, and emphasize too much reading. Observation as well as performance activities and written tests are important in evaluating the children's learning.

What can the teacher do to improve elementary science experiences? An individual teacher or a group of teachers may work on their own science teaching problems by:

1. Studying the children by means of office records, autobiography, observation.
2. Studying present program to see if objectives, activities, and evaluation measures are present.
3. Studying teaching aids, such as children's textbooks, teachers' texts, films, records, community resources.
4. Consulting science teachers in the high school, science clubs, science books, science teachers in colleges, and participating in science workshops.

The following is an example of a source bulletin which may be developed by a teacher or a group of teachers in the process of improving the children's learning experiences.

COMMUNITY RESOURCES IN THE STUDY OF THE CONSERVATION OF NATURAL RESOURCES

One of the vital problems in the lives of people of the United States is the conservation of natural resources. In order for our citizens to have an understanding of this problem, it is necessary for each child from the primary level on through high school, college, and adult life to be exposed to and sensitized to this need. Teachers will find their community to be an excellent source of worthwhile experiences for their children. A suggested list of possible community resources is given below. By surveying their community, the teacher and the children will be able to extend the list and add specific notes as to the locations of parks and conservation projects, names of speakers, etc.

1. Areas
   - Arboretums
   - Breeding farms
   - Camp sites
   - Farms
   - Forests
   - Gardens
   - Meadows
   - Parks
   - Picnic grounds
   - Rivers
   - Streams
   - Vacant lots
2. People
   - Animal breeders
   - College professors—agriculture, botany, forestry
   - County agriculture agents
   - Forest rangers
   - Gardeners
   - Park commissioner
   - Vocational agriculture teacher
3. Projects
   - Conservation districts
   - County fairs and exhibits
   - Experiment stations
   - School farms and gardens
4. Associations
   - American Forestry Association
     Washington, D. C.
   - Garden Club of America
     New York, New York
   - National Audubon Society
     New York, New York
   - National Wildlife Federation
     Washington, D. C.
5. Institutions
   - Libraries
   - Museums
   - Schools and Colleges
6. Industries
   - American Forest Products Industries, Inc.
     Washington, D. C.
   - American Petroleum Institute
     New York, New York
   - American Potash Institute
     Washington, D. C.
   - Bituminous Coal Institute
     Washington, D. C.
   - International Harvester Co.
     Chicago, Illinois
7. Films
   - Films for rent
     - Creative Educational Society
       Mankato, Minnesota